



# UNIVERSITIES SPACE RESEA

## High Energy Astrophysics Program

CR-206885

7501 Forbes Blvd., Suite 206  
Seabrook, MD 20706-2253  
Tel: (301) 805-8396  
Fax: (301) 805-8466

NASA/GOD  
Mail Code 610.3  
Greenbelt, MD 20771  
Tel: (301) 286-5057

### Member Institutions

Alabama A&M University  
Alabama, University of  
(in Huntsville)  
Alaska, University of  
Arizona, University of  
Arizona State University  
Boston College  
Boston University  
Brandeis University  
British Columbia, University of  
Brown University  
California, University of  
(Berkeley)  
California, University of  
(Los Angeles)  
California, University of  
(San Diego)  
California, University of  
(Santa Barbara)  
Case Western Reserve University  
Chicago, University of  
Colorado, University of  
(Boulder)  
Connecticut, University of  
Cornell University  
Delaware, University of  
Denver, University of  
Florida State University  
Florida, University of  
(Gainesville)  
Georgetown University  
George Washington University  
Georgia Institute of Technology  
Hampton University  
Harvard University  
Hawaii, University of, (Manoa)  
Houston, University of  
Illinois, University of  
(Urbana - Champaign)  
Indiana University  
Iowa State University  
Iowa, University of  
Johns Hopkins University  
Kansas, University of  
Lehigh University  
Louisiana State University  
Maryland, University of  
(College Park)  
Massachusetts Institute of Technology  
Michigan, University of  
Michigan Technological University  
Minnesota, University of  
New Hampshire, University of  
New Mexico, State University of  
New York, State University of  
(Buffalo)  
New York, State University of  
(Stonybrook)  
New York University  
North Carolina A&T University  
North Carolina State University  
Northwestern University  
Ohio State University  
Old Dominion University  
Pennsylvania State University  
Pittsburgh, University of  
Princeton University  
Purdue University  
Rensselaer Polytechnic Institute  
Rice University  
Rochester, University of  
Rockefeller University  
Sheffield, University of  
Southern California, University of  
Stanford University  
Tel-Aviv University  
Tennessee, University of  
Texas A&M University  
Texas, University of, (Austin)  
Texas, University of (Dallas)  
Texas, University of  
(Medical Branch, Galveston)  
Toronto, University of  
Utah State University  
Vanderbilt University  
Virginia Polytechnic Institute  
and State University  
Virginia, University of  
Washington, University of  
Washington University (St. Louis)  
William and Mary, College of  
Wisconsin, University of (Madison)  
Yale University

July 7, 1998

To: See Distribution List

Enclosed is the Technical Report for the USRA/High Energy Astrophysics Program under Contract NAS 5 - 32490 for the period of October 1, 1997 through March 31, 1998. Please contact me if you have any questions or need further information.

Sincerely,

David V. Holdridge  
Project Manager, HEAP



**Contract No. NAS 5 – 32490**

**Technical Reports  
Distribution List**

**Quantity**

1	Michael McGrath Contracting Officer Mail Code 286 NASA/Goddard Space Flight Center Greenbelt, MD 20771
3	Dr. Jay Norris Mail Code 662 NASA/Goddard Space Flight Center Greenbelt, MD 20771
1	Publication and Graphics Services Section Mail Code 253.1 NASA/Goddard Space Flight Center Greenbelt, MD 20771
2	NASA Center for Aerospace Information (CASI) Attn: Acquisition Department 7121 Standard Drive Hanover, MD 21076
1	Dr. William E. Howard III USRA 300 D Street, SW, Suite 801 Washington, DC 20024
1	David V. Holdridge HEAP Project Manager 7501 Forbes Blvd., Suite 206 Seabrook, MD 20706-2253
1	Russell Walker Contract Specialist USRA 10227 Wincopin Circle American City Building, Suite 212 Columbia, MD 21044



**HIGH ENERGY ASTROPHYSICS PROGRAM  
(HEAP)**

**NASA CONTRACT**

**NAS 5 – 32490**

**Technical Report**

**October 1, 1997 thru March 31, 1998**

**UNIVERSITIES SPACE RESEARCH ASSOCIATION  
(USRA)**

**David V. Holdridge  
Project Manager**



## TABLE OF CONTENTS

### **Task 93-01-00 – HEASARC**

Angelini, Lorella .....	01
Corcoran, Michael.....	04
Drake, Stephen.....	05
McGlynn, Thomas A. ....	08

### **Task 93-02-00 – ROSAT-GOF**

Snowden, Stephen.....	10
-----------------------	----

### **Task 93-03-00 – ASCA-GOF**

Mukai, Koji.....	12
------------------	----

### **Task 93-04-00 – XTE-GOF**

Cannizzo, John.....	14
Lochner, James .....	16
Rots, Arnold.....	17

### **TASK 93-07-00 – ACE**

Christian, Eric .....	18
-----------------------	----

### **TASK 93-09-00 – RMT/BATSE**

Barthelmy, Scott .....	20
------------------------	----

### **TASK 93-10-00 – TGRS/WIND**

Palmer, David .....	22
---------------------	----

### **Task 93-11-00 – HE Cosmic Rays**

Mitchell, John .....	24
----------------------	----

### **Task 93-12-00 – EGRET**

Esposito, Joseph.....	28
Sreekumar, P.....	31

### **Task 93-13-00 – Theory**

Hua, Xin-Min.....	32
Mandzhavidze, Natalie .....	33

### **Task 93-14-00 – Mirror Development**

Chan, Kai-wing .....	34
----------------------	----





Soong, Yang.....	38
<b>Task 93-20-00 – CGROSSC</b>	
Barrett, Paul .....	39
Bonnell, Jerry .....	41
Bridgman, W. Tom .....	42
Macomb, Daryl .....	44
Shrader, Chris .....	46
Watanabe, Ken.....	48
<b>Task 94-07-00 – XTE-SOF</b>	
Corbet, Robin.....	50
Moiseev, Alexander .....	52
<b>Task 97-02-00 – ASTRO-E</b>	
Ebisawa, Ken .....	53
<b>Task 97-03-00 – Detector Technology</b>	
Krizmanic, John .....	55
<b>Task 97-05-00 – INTEGRAL Software</b>	
Naya, Juan.....	57
<b>Task 98-01-00 – Space Physics</b>	
Baring, Matthew .....	59



**University Space Research Association High Energy Astrophysics  
Program**

**Technical Report October 1, 1997 to March 31, 1998**

**Task 5030/93-01-00 – HEASARC**

**Lorella Angelini:**

Software Development, Maintenance and Support:

XRONOS: I have been working on the maintenance of the XRONOS software. I made a number of revisions and updates upon user-request. The version 5.1 will be distributed with the latest FTOOLS release May 1998. I have also created a new task for orbit correction, but this is not included in this release.

XIMAGE: The program is going under a major revision to be in shape for the AXAF data. The Major changes include: 1- Plotting of the imaging, 2- Input mission databases set-up, 3- A reader capable to create images using a pair of coordinates but using values from a 3<sup>rd</sup> dimension for the image-histogram, 4- Change all the calibration file to use FITS file. Micah Jonston works with me on this project under my supervision.

Restoration:

The restoration group that I am leading finished the restoration in FITS of the following data sets: HEAO1 A2, EXOSAT LE instrument, OSO8 rate for the A, B, and C detectors. For each of the data sets the following has been done:

EXOSAT: The EXOSAT raw data for the LE instrument are currently available from the legacy FTP area. Xselect (program which allowed for data selection and creation of lightcurve, images and spectra) has been modified to accept the EXOSAT LE data. These modifications are included in the next FTOOLS release. In addition 3 others tasks are available to correct the data for deadtime, create pha files, and calculate vignetting. These tasks will be inserted as a package within FTOOLS after the current release. Documentation to analyze the data will be available through the WEB.

OSO-8 rate: The raw rate data are on-line and a database is available to browse and retrieve the data. FTOOLS compatible programs have been written to extract

lightcurves from the rate data for the B and C detector and will be included as package within FTOOLS after the current release. Lightcurves for the B and C detectors (and GIF files) have been extracted for about 300 positions which I am currently quality screening. We are working in restoration the PHA data for the B and C detector.

HEAO1 A2: On-line are available the following data: the Raw rate data, lightcurves for the pointing and scanning phase of HEAO1 (the lightcurves are available as FITS and GIF format). The data can all be searched and retrieve via databases under W3browse and browse. FTOOLS compatible programs have been written to extract the lightcurves and will be included as package within FTOOLS after the current release.

In the next 6 months the plan is: 1- include the EXOSAT, OSO-8 and HEAO1 packages in FTOOLS, 2- finish the OSOS-8 PHA and Rate data for the A detector, 3- update all the On-line documentation for the Mission pages, 4- start the reformatting of the EXOSAT LE and Copernicus data.

#### SAX US Coordination Facility:

In the past 6 months I have done the following: 1- regularly update the log observation files for the SAX NFI and WFC instruments (one every two months), 2- helping the SDC with the AO2 for the GO and core program (update all the tools and the documentation for proposal preparation), 3- mounting locally the software to run the pipeline for the NFI instruments LECS, MECS and PDS.

For the archive exchange with the SAX data center, I have been working to create CDs of the ROSAT HRI and PSPC data. HEASARC has currently hardware to massively produce CDs. Together with the system manager, Phil Newman, we have now a pipeline that produces CDs for the data archived at HEASARC. ROSAT data was the first data set we put on the CDs. We produced seven sets of 36 CDs each. Each set contains all the ROSAT public data available in the HEASARC archive up to March 1998. One of the seven has been shipped to the SAX-SDC and the other will be distributed to other data center. The plan is to create a CDs version of the ASCA archive and issue new ROSAT CDs after a substantial update of the archive.

Community Services: I have been a reviewer in the first AXAF AO1 review.

Papers accepted for publication:

- "ASCA and Ginga Observations of GX1+4", 1998, Kotani, T., Dotani, T., Nagase, F., Greenhill, J. G., Pravdo, S. H., Angelini, L., ApJ
- "Synchronization Timescales for Binary Star and Star Plus Planet Systems with Solar-Type Primary Stars," 1998, Drake, S., Angelini, L., Pravdo, S., and Stern, A. J., A.J.
- "Hydrogen-Like Ion Emission in the Spectra of Low Mass X-Ray Binaries," 1998, Bautista, M. A., Kallman, T. R., Angelini, L., Liedahl, D. A., Smits, D. P., ApJ
- "RXTE Observations of RX J0146.9+6121: A New X-ray Outburst of the Be/X-ray Pulsar," 1998, Haberl, F., Angelini, L., and Motch, C., A & A
- "The Discovery of 12min X-ray Pulsations from 1WGA J1958.2+3232," 1998, Israel, G. L., Angelini, L., Stella, L., Campana, S., Giommi, P., White, N. E., MNRAS

Conference Proceedings and IAU:

- "SAX and XTE Observations of GX1+4, SMCX-1 and RXJ0146.9+6121, A Sample of X-ray Pulsators with Extreme Properties," 1998, Israel, G. L., Stella, S., Angelini, L., et al, proceedings of "The Active X-Ray Sky: Results from BEppo-SAX and ROSSI-XTE," Rome, Italy, October 1997
- "XTE J0053-724," 1998, Buckley, D. A. H., Coe, J., Stevens, J., B., Angelini, L., White, N. E., Giommi, P., IAUC 6789
- "EXOSAT Observation of M31," 1997, Garcia, L., and Angelini, L., AAS, page 1292
- "H and He-like Ions Emission in the Spectra of X-Ray Binaries," 1997, Bautista, M., Kallman, T., White, N. E., Angelini, L., AAS, 1397

Proposal Submitted: I have been CO-I in 5 accepted proposals for the SAX AO2. I am PI of one AXAF proposal and CO-I in other proposals. The results of the AXAF AO1 review is not yet available.

## **Task 5030/93-01-00 – HEASARC**

### **Michael Corcoran:**

#### Science Tasks:

During this interval I published 3 papers (Nature 390, 587; ApJ, 494, 381; and New Astr, 3, 241) all on the topic of the X-ray emission from the supermassive Eta Carinae. I also attended the Hot Stars in Open Clusters workshop in La Plata, Argentina where I presented an invited talk. I organized and contributed to a special session at the 191st AAS meeting in Jan. in DC on the topic of recent changes in the multi-wavelength emission of Eta Car. I'm currently on the organizing committee of the "Eta Car."

#### Programmatic Tasks:

**CALDB:** working with L. Breedon (RSTX) I've totally revised and updated the HEASARC CALDB web site. I've also continued ROSAT Results Archive activities including data screening, and software development. We've worked with T. Bridgman (USRA) to develop calibration data formats for the CGRO OSSE instrument.

**RRA:** I've released a new version of the screening software for the HRI RRA data and have installed and written a driver for the PSPC RRA software written by T. Boller. I've also taken the lead on developing the data pipeline for release transfer of RRA data to the RRA centers and have written software to transfer and verify ROSAT HRI RRA data. Working with E. Sabol I've developed the scheme for release of RRA data products for access through the BROWSE and W3BROWSE interfaces. J. Englhauser (MPE), D. Harris (SAO), M. Arida (RSTX) and I have been putting the final touches on the HRI RRA catalogue table and this should be ready for release in early May.

**ROSAT GOF:** responded to e-mail requests for information. Also began development of the ROSAT IMAGES CDrom, volume 8, which should be released at the Jun AAS meeting.

**USRA:** I contributed to the USRA/NYMA proposal for code 630 operations.

## Task 5030/93-01-00 – HEASARC

**Steve Drake:**

### WORK ACCOMPLISHED AND IN PROGRESS

#### (i) Science Related

##### - Guest Investigator Proposal Status

Of the 6 ASCA Cycle 6 proposals of which I was a Co-Investigator, 4 of them had targets accepted: 24 UMa and 29 Dra (PI: Ted Simon, U. Hawaii), UX Ari (PI: Nick White, GSFC), and Eta Car (PI: Mike Corcoran, USRA), for a total of 290,000 seconds of observing time. Of the 3 RXTE Cycle 3 proposals of which I was a Co-Investigator, 2 of them had targets accepted: HR 1099 (PI: Alec Brown, U. Colorado), and Eta Car (PI: Mike Corcoran), for a total of 210,000 seconds of observing time. Finally, in January 1998 I submitted 2 AXAF Guest Observer (GO) proposals for their AO-1 that requested a total of 4 stars (Algol, UX Ari, Beta Cet, and Epsilon Eri) be observed for a total of 200,000 seconds of exposure time. I was also a Co-I on another proposal led by Manuel Guedel (Paul Scherrer Institute, Switzerland) to observe the star YY Men. As of the time of writing, the status of these AXAF proposals had not been determined.

##### - Scientific Publications

My final tally for 1997 was 5 papers and 6 abstracts published. Of the 5 papers, 2 were in refereed journals, and 3 were in conference publications or newsletters. In 1998 so far, I have had 2 papers published, 2 more are in press, 3 more papers have been submitted, and 3 papers are in preparation. (See the attached bibliographies for 1997 and 1998).

##### - Conferences, Meetings, and Workshops

From October 27 - 29 1997, I attended the European Working Group (EWG) on Chemically Peculiar (CP) Stars Meeting that was held in Vienna, Austria, and gave a review talk on the X-ray and radio properties of Magnetic CP Stars. Later I wrote this oral presentation up for a paper that will appear in the meeting proceedings (see my 1998 bibliography).

From November 4 - 7 1997, I attended the High Energy Astrophysics Division (HEAD) of the AAS Annual Meeting that was held in Estes Park, Colorado.

From January 7 - 9 1998, I attended the Winter AAS Meeting that was held in Washington, D.C. Inter alia, I helped to host the Constellation X-ray mission exhibit at this meeting.

##### - Refereeing and Proposal Reviewing Duties

I participated in the RXTE AO-3 Reviews that were held from November 8 – 10 1997 in Estes Park immediately following the HEAD Meeting. I also was drafted to serve in the AXAF GO AO-1 Reviews that are to be held in the Boston area in early April 1998.

- Other Science Activities

As part of the radio program in support of an ASCA observation of the interesting luminous O star 9 Sgr (Wayne Waldron (HITC) is the PI and I am a Co-I), I planned a series of Very Large Array (VLA) observations that were made contemporaneously with the X-ray observation. I subsequently visited the NRAO Headquarters at Charlottesville on January 2 - 3, 1998, in order to reduce these VLA data in time for them to be discussed in a poster presentation at the Washington AAS Meeting that was held 5 days later.

(ii) Programmatic

I continued to monitor the WWW, anonymous ftp and Gopher services provided by the HEASARC to the scientific community. We are presently transferring data via ftp, http, and Gopher utilities at a total rate of about 50 Gigabytes per month, which is about a factor of 2 higher than it was a year ago. The HEASARC data archive has reached a size of about 950 Gigabytes, which is again about double what it was just a year ago. This increase is due to the continuing burgeoning of the RXTE, ASCA, and ROSAT Archives, the migration of the main CGRO Archive to HEASARC's Legacy computer, and the transfer of the EUVE Science Archive from the Center of Extreme-Ultraviolet Astrophysics (CEA) in Berkeley, California to the HEASARC of the main EUVE Science Archive. As part of the latter activity, I, together with Tom McGlynn (USRA) and Karen Smale (Raytheon STX) set up the HEASARC EUVE Archive WWW site.

I also continued to monitor the HEASARC's e-mail hotline "request@athena". In the period covered by this report, I accumulated 320 messages in my 'request' mail folder, about equally divided between messages to request and our replies. In addition, I re-directed another 117 messages to the public outreach hotline "ask\_astro@athena".

I took over the maintenance of the HEASARC Upcoming Proposal Deadlines and Upcoming Meetings WWW pages from Ian George. I started a 'New Databases' WWW page accessible from the W3BRowse Launch page so that users could quickly see what databases had been added or updated recently.

The HEASARC Director, Nick White, asked me to be the scientific editor for the next issue of the HEASARC journal



Legacy. I coordinated with him as to the contents of this issue, and then solicited articles from the selected potential authors. As of the end of the period covered by this report 1 out of about 20 articles had been received (not surprising as the due date I had given was April 15, 1998, and astronomers are notorious procrastinators!).

In the six-month period covered by this report we created 17 new databases, and updated or fixed bugs in 7 other databases. (See attached list).

#### NON-LOCAL TRAVEL

1. To Vienna, Austria to attend EWGCPS Meeting from Oct 27 - 29, 1997 (see above).
2. To Estes Park, Colorado to attend HEAD Meeting and RXTE AO-3 Reviews from Nov 4 - 10, 1997 (see above).
3. To Charlottesville, VA to analyze VLA data (see above).

#### WORK PLANNED FOR NEXT SIX MONTHS

I will continue my research into the coronae of stars using hard X-ray, soft X-ray, extreme-ultraviolet, and radio observations as probes of their physical environments.

I will continue overseeing the anonymous ftp account on HEASARC's LEGACY computer, as well as the request@legacy user hotline. I will continue monitoring our creation of BROWSE and W3BROWSE databases and catalogs. I will keep those WWW pages for which I have responsibility up to date.

I will attend the RXTE GO AO-1 Reviews that are to be held in Waltham, Massachusetts from April 5 -7, 1998.

## **TASK 5030/93-01-00 - HEASARC**

**Thomas McGlynn:**

### **Major Accomplishments:**

Major enhancements have been made to the HEASARC archive and Web systems. The HEASARC Astrobrowse effort has been recognized and supported by NASA HQ as a substantial step in uniting NASA's space sciences holdings. The Astrobrowse service indexes and accesses more than 1,000 distinct resources at many institutions both in the US and abroad. The Astrobrowse system is being developed in collaboration with the Centre Dunees Astronomiques de Strasbourg (CDS) and in cooperation with many other institutions in the US and abroad.

Substantial improvements have been made to the HEASARC's archive system. The underlying database system was finally changed from Ingres to Sybase culminating a 2-year transition and providing more efficient access. The HEASARC became the primary physical archive for EUVE data. Our rapid ability to ingest the EUVE data and increasing cooperation with ST ScI and the NSSDC have obviated the need to have multiple on-line copies of the data.

A new and faster computer has been installed as the main SkyView server. Usage has increased by approximately 30% in the two months new server has been in place. Only a small increase in SkyView usage had been seen in the previous year so apparently we had been reaching saturation.

Work continued on a variety of tasks including upgrades to other elements of the HEASARC's archives and Web services and research on clusters of galaxies.

### **Upcoming:**

The Astrobrowse effort is continuing and expanding and becoming a major cooperative international effort. The HEASARC will play a leading role in a proposal to extend Astrobrowse to integrate resources from disparate sites. This effort is likely to include participants from ST ScI, NCSA, JPL, CDS and the Italian Space Agency.

An AISR proposal for further funding for SkyView will be submitted.

Two new optical surveys are due to come on-line in SkyView: access to the DSS2 images at 1" and the first low-resolution digitized observations of the sky. The second fills the curious gap that there is no low-resolution optical image available of the entire

sky. This image is being generated by a careful remapping and resampling of the DSS survey.

Further enhancements to the W3Browse database system are planned including substantial new facilities to assist in the development of new databases.

In cooperation with collaborators at JPL, the SkyMorph project will be demonstrated at the June AAS meeting.

## **Task 5030/93-02-00 – ROSAT-GOF**

### **Steve Snowden:**

#### **ROSAT Guest Observer Facility Programmatic Work:**

Currently my duties are still split between the ROSAT and XMM GOFs. I'm slowly making the transition between the two but will continue to be available to the ROSAT project when appropriate.

#### **XMM GOF**

My XMM GOF duties thus far have included learning about the observatory, creating GOF web pages, organizing a US project leader conference here at GSFC, organizing an XMM booth for the San Diego AAS meeting, and familiarizing myself with the XMM documentation and software.

#### **ROSAT GOF - Extended Source Analysis Software**

I've continued the task of maintaining and answering GO questions about this software package. Kip Kuntz and myself are nearly done in our preparation of a final version of the ESAS package. The software has been made more intelligent to simplify its use and to make pipelining of tasks considerably more convenient. We have also produced a major revision of the documentation.

#### **TREND Data Analysis**

The TREND data processing continues in production mode with 2494 days completed. The reprocessing of GO data is complete so only new data are being reduced.

#### **PSPC Spectral Calibration**

No real progress here. MPE will not release the new XRT mirror effective areas so improvement of the calibration must be done there. Jane Turner and I produced a memo discussing the calibration of the residual spatial gain variation but are waiting on MPE (at their explicit request) for publication.

#### **HRI Particle Background Calibration**

I completed my work on the HRI particle background calibration which has resulted in an accepted paper which will appear in ApJ Sup.

#### **Scientific Work**

My paper presenting an analysis of the ROSAT all-sky survey data in the 1/4 keV band has been published. The analysis in this paper is the scientific reason that I became involved in the ROSAT project ten years ago.

#### **Public Outreach**

I am a member of the HEASARC Public Outreach group and have been participating in the creation of the WWW education pages.

My mentoring of University of Maryland graduate student Kip Kuntz is in its last half a year.

#### Travel

HEAD meeting in Estes Park to present my work on the HRI particle background.

#### Plans for the Next Half Year

#### XMM

I'll be taking several trips in support of the XMM GOF. 1) A trip to Leicester to discuss cooperation in the project. 2) I'll attend the SSC meeting in Garching. 3) I'll run the XMM booth at the San Diego AAS meeting. 4) I'll attend the XMM workshop at ESTEC in the fall. Otherwise I'll be preparing to support the XMM GOF to support the first AO in the fall.

#### ROSAT

Trend processing will continue but with a smaller time commitment. I'll make the final release of the ESAS package and help with the ROSAT Senior Review proposal and with ROSAT AO-9, if there is one.

#### Science

Scientifically, my mentoring of Kip Kuntz. I am nearly ready to submit a paper on shadows in the ROSAT all-sky survey.

**Task 5030/93-03-00 – ASCA GOF**

**Task 5030/97-02-00 – ASTRO E**

**Koji Mukai:**

1. ASCA Matters:

In addition to the routine GO support (mostly answering questions via e-mail), my ASCA works over the previous six months included:

1. ASCA AO-6 review Oct. 15-17 and the Japan-US merging meeting, Nov 19-10;
2. Assisting the SIS team in the area of Low-Energy calibration;
3. Developed and tested a new screening criterion for SIS data; and
4. Tested and debugged ASCA related software in the FTOOLS v4.1 package.

2. ASTRO-E Matters:

In January 1998, I attended the Critical Design Review of the XIS instrument on ASTRO-E, held at MIT, for the purpose of learning about the instrument.

The focus of our work here was the Project Data Management Plan (PDMP) and related agreement on software and processing pipeline design between GSFC and the hardware teams. The writing of PDMP was done mostly by Ken Ebisawa. In a series of meetings in March 1998 (with about 8 Japanese visitors), we have reached a broad agreement on the division of labor between the hardware teams and the GSFC software team.

Also in March 1998, I attended the Science Working Group meeting in Hawaii.

3. Research Activities:

I have attended 3 scientific meetings during this period: Maryland conference, Oct. 13-15; HEAD meeting, Nov. 4-7; and Winter AAS meeting, Jan. 7-10.

During this period, I have worked on several papers on which I am (will be) a co-author, and submitted 2 AXAF proposals.

The following paper has appeared in refereed journals during this period:

Hellier, C., Mukai, K., & Beardmore, A. P., 1997, "An Outburst of the Magnetic Cataclysmic Variable XY Arietis Observed with RXTE" MNRAS 292, 397-406.

4. Talks and public outreach:

I gave a colloquium at the Physics Department of Virginia Tech, on "Results from the ASCA mission", Oct. 2.

I continued to participate in the public outreach activities at LHEA, including 3 separate periods answering questions for the "Ask a NASA Scientist: service, totaling ~100 questions.

5. Projection of Future Activities:

I will participate in the AXAG proposal review in April, and work on the ASCA announcement and review organization. I will probably attend the summer AAS meeting in San Diego, and definitely organize and attend a workshop on magnetic cataclysmic variables in Annapolis in July. In addition to the routine ASCA and ASTRO-E works, there may be a trip to the next ASTRO-E Science Working Group (probably in Japan, probably in September).

**Task 5030/93-04-00 – XTE-GOF**

**John Cannizzo:**

Talks:

Colloquium, Univ. of Virginia, Charlottesville, VA., Sep 30, 1997  
“Accretion Disks in Interacting Binary Stars”

Lab. for High Energy Astrophysics seminar, Goddard, Mar 9, 1998  
“Constraints on the Physics of Accretion Disks from SS Cygni”

Refereeing Journal articles:

Astrophysical Journal (US): - 3

Monthly Notices of the Royal Astronomical Society - 1

Publications of the Astron. Soc. of the Pacific - 2

Conference: AAS Meeting in Washington DC - Jan 1998

Committee: NSF Panel in Arlington, VA - Dec 1997

Papers:

Cannizzo, J. K. 1998, “On the  $M_V(\text{peak})$  versus Orbital Period Relation for Dwarf Nova Outbursts,” The Astrophysical Journal, 1998, January 20, vol. 493, pp. 426-430.

Cannizzo, J. K. 1998, “The Accretion Disk Limit Cycle Mechanism in the Black Hole X-Ray Binaries: Toward an Understanding of the Systematic Effects,” The Astrophysical Journal, 1998, February 10, vol. 494, pp. 366-380.

Cannizzo, J. K. 1996, “Accretion Disks in Transient Systems,” in ASP Conf. Ser 137, Proceedings of the 13th North American Workshop on Cataclysmic Variables and Related Objects, in press

Functional:

Prior to 1 Jan 1998, the main functional work consisted of Thurs-Fri shift work in the Science Operations Facility of RXTE. After 1 Jan 1998, I was transferred to the Guest Observer Facility, where the emphasis is now placed on facilitating the data reduction work of the RXTE guest observers.

1997 Science Citation Index Listings (first author listings only)

1 - CANNIZZO-JK-1982-ASTROPHYS-J-LETT-V260-PL83

1 - CANNIZZO-JK-1982-PULSATIONS IN CLASSICAL AND CATAclysmic VARIABLES

3 - CANNIZZO-JK-1984-ASTROPHYS-J-SUPPL-V55-P367

2 - CANNIZZO-JK-1984-NATURE-V311-443



3 - CANNIZZO-JK-1986-ASTROPHYS-J-V301-P634  
 1 - CANNIZZO-JK-1986-ASTROPHYS-J-V309-PL43  
 1 - CANNIZZO-JK-1988-ASTROPHYS-J-V320-P319  
 1 - CANNIZZO-JK-1988-ASTROPHYS-J-V327-P840  
 4 - CANNIZZO-JK-1988-ASTROPHYS-J-V333-P227  
 1 - CANNIZZO-JK-1988-ASTROPHYS-J-V334-PL31  
 1 - CANNIZZO-JK-1990-ASTROPHYS-J-V351-P38  
 1 - CANNIZZO-JK-1992-ASTROPHYS-J-V386-PL17  
 1 - CANNIZZO-JK-1992-ASTROPHYS-J-V401-P642  
 1 - CANNIZZO-JK-1992-SCIENTIFIC-AMERICAN-P42  
 15 - CANNIZZO-JK-1993-ACCRETION DISKS IN COMPACT  
 STELLAR SYSTEMS-P6  
 7 - CANNIZZO-JK-1993-ASTROPHYS-J-V419-P318  
 2 - CANNIZZO-JK-1994-ASTROPHYS-J-V435-P389  
 8 - CANNIZZO-JK-1995-ASTROPHYS-J-V454-P880  
 9 - CANNIZZO-JK-1996-ASTROPHYS-J-V466-PL31  
 1 - CANNIZZO-JK-1996-COMMUNICATION  
 1 - CANNIZZO-JK-1996-ASTROPHYS-J-V473-PL51  
 1 - CANNIZZO-JK-1996-IAU-C-V158-P135  
 1 - CANNIZZO-JK-1996-MEM-SOC-ASTRON-ITAL-V67-P269

## **Task 5030/93-04-00 – XTE-GOF**

### **Jim Lochner:**

During the past half year, while continuing to support day-to-day activities in the RXTE Guest Observer Facility, I have carried out RXTE observations of transient pulsars in the Small Magellanic Cloud, and have continued to pursue education and outreach activities.

With Maggie Masetti (STX), I continued development on the RXTE Learning Center. This consisted primarily of finishing the major design elements for the education interface for the ASM products we had started with Mr. Bud Worth this past summer. In addition, we continued to write RRXTE DiscoveryS articles for the latest new discoveries from RXTE. We also designed a paper model of RXTE and started writing an accompanying activity book.

I also continued to coordinate the RAsk a NASA ScientistS Feature of the Imagine the Universe! education website. The activity on this grew significantly over the past six months, with just 131 questions in October increasing to 469 questions in March. A great deal of time was spent trying to keep up with the increase, modifying the web pages to attempt to decrease the number of questions, and finally instituting new policies about not answering all the questions. I also supervised the upkeep of the web archive of selected previously answered questions, and recruited new participants to the service. These changes brought some stability (and some greater happiness to those answering the questions!)

In late November, Dr. Frank Marshall (GSFC) notified me that it appeared that one of my proposed transient sources was in outburst. I initiated a set of RXTE observations to monitor the region near the transient SMC X-3. Over the course of the next 3 months, with my Co-Is Dr. Laura Whitlock (USRA) and Dr. Niel Brandt (Penn State), we discovered the appearance or reappearance of 5 transient x-ray pulsars in this region. With the assistance of Dr. Frank Marshall and Dr. Robin Corbet (USRA), we also obtained observations by ASCA and Beppo-SAX to carry out precise position determinations of these sources. All the sources have the characteristic spectra and outburst behavior of Be/ns transients, which consist of a neutron star in an eccentric orbit around a mass-ejecting B star. After dimming in x-rays, one of the sources brightened again in February, giving evidence for a possible binary orbital period. The irony of this adventure is that SMC X-3 was never in outburst, but it was rather two of these nearby pulsars. Analyses of these data are continuing.

**Task 5030/93-04-00 – XTE GOF**

**Arnold Rots:**

During this I finished the new barycenter and planetary ephemeris code which will enable the user to employ either DE200 or DE405. It is also mission-independent and will be used for AXAF. I presented one oral paper at the 1997 HEAD meeting, in the XTE session, on timing, and one poster paper, on the Crab timing results. I attended the symposium on Neutron Stars and Pulsars in Tokyo, in November, and presented a poster paper on XTE results for the pulsars B1509-58, B1821-24, and the Crab.

The XTE pulsar timing paper was revised and sent off to ApJ.

I provided science and technical support for the XTE peer review.

## **Task 5030/93-07-00 - ACE**

### **Eric R. Christian:**

#### **ACE (Advanced Composition Experiment):**

ACE is an Explorer that successfully launched in August to study the solar wind, and heliospheric and low energy galactic cosmic rays. I am Deputy Project Scientist (Tycho von Rosenvinge is now Project Scientist, formerly it was Jon Ormes). I am also an Instrument Scientist on the CRIS and SIS experiments on ACE. Since launch, I have been involved with flight operations and data analysis on SIS and CRIS. We already have more data in the first half-year on SIS and CRIS than all previous instruments combined.

I am the author and curator for about 40 pages on the World Wide Web for the ACE spacecraft (<http://www.gsfc.nasa.gov/ace/ace.html>). A substantial amount of time this last half year has been spent on education and public outreach. I am one of the two people who work on the Cosmic and Heliospheric Learning Center, a web-based site aimed at High School age and above that teaches about the science of ACE. The site was included on the 20,000 copies of the Imagine the Universe CD that is being distributed across the country. I also put in a proposal to the Explorer Project Office to fund ACE outreach at Goddard that was accepted, and helped Caltech and Los Alamos with similar proposals. I also support Old Bridge High School which has adopted ACE as part of the Cooperative Satellite Learning Program and have given several talks this year at the high school.

I was a co-author on three papers (on the ACE mission, CRIS, and SIS) that have been accepted for publication in a special Space Science Reviews issue on ACE.

#### **IMAX (Isotope Matter-Antimatter eXperiment):**

IMAX is a balloon experiment that we are working on with Caltech, U. of Siegen, and NMSU to measure the fluxes of anti-protons, and hydrogen and helium isotopes over a wide energy range. One paper, "The Cosmic Ray  $3\text{He} / 4\text{He}$  Ratio from 200 MeV / nucleon to 3.7 GeV / nucleon" by O. Reimer et al. was published in ApJ this half-year, and two other papers on the galactic cosmic ray hydrogen and helium energy spectra and the antiproton fluxes are about to be submitted.

#### **ISOMAX (ISotope MAGnet eXperiment):**

This is another magnetic spectrometer balloon experiment in collaboration with Caltech and U. of Siegen. It is specifically designed to look at the isotopic composition of beryllium, because  $10\text{Be}$  is a very important clock that can measure the lifetime of all cosmic rays. I am responsible for the onboard command and data

handling (C&DH) system and the computer ground support equipment (GSE).

The hardware is working, and functional C&DH and GSE software systems are up and running, but both systems are in the process of being expanded. We are currently planning to launch from northern Canada this summer.

TIGER (Trans-Iron Galactic Element Recorder):

TIGER is a balloon borne experiment designed to look at ultra-heavy galactic cosmic rays. It is a collaboration with Washington U. (St. Louis), Caltech and U. of Minnesota. After a successful balloon flight in the summer of 1997, TIGER has now been accepted as the trial payload for the Ultra Long Duration Balloon program, attempting to fly for 100 days. I am Goddard instrument manager for TIGER (meaning I am taking the lead for the Goddard part of the instrument). The TIGER instrument is also the prototype for a part of a future space station experiment (called ACCESS, see below).

ACCESS (Advanced Cosmic-ray Composition Experiment for the Space Station):

This is the new big gorilla. ACCESS is being studied for launch to the space station in 2005 (or later). It is composed of three relatively disjoint experiments: a calorimeter to study light nuclei at about  $10^{14}$  eV energy, a transition radiation detector to study heavier nuclei at  $10^{14}$  eV, and an ultra-heavy (heavier than iron) detector at lower energies. The UH part is, at some level, TIGER in space, and is the same collaboration, again with me taking the lead for the Goddard parts. I am also Deputy Study Scientist (Bob Streitmatter is Study Scientist) for the whole thing. As part of ACCESS, I spent ten days at Brookhaven Nat. Accelerator helping test some prototype ACCESS-UH detectors.

On top of all this, I continue to be system manager for three UNIX computers, and the various PCs and Macs in the high-energy cosmic ray group. As well as participate in several other collaborations (OWL and PAMELA) at lower levels.

**Task 5030/93-09-00 – RMT/BATSE**

**Scott Barthelmy:**

GRIS project activities:

Nothing to report. GRIS is in stasis awaiting a nearby supernova.

GCN (BACODINE) project activities:

The GCN (GRB Coordinates Network) project continues grow. The nearly 10 optical and radio counterparts to recent GRBs in the last year has brought the state of GRB follow-up research into high gear. The current number of GCN sites is >90 and growing.

GCN continues collects and distributes location information from other spacecraft. The other sources are Huntsville refined positions, ALEXIS, IPN, RXTE-PCA. COMPTEL and RXTE-ASM were added to the list. The GCN web site now has pages/tables which are updated in realtime with all this information – it serves as another distribution method and as an archive.

The GCN Circulars were added to the system. These "circulars" are reports submitted by the burst follow-up community (optical, radio, x-ray, etc), and are prose-style (as opposed to the highly formatted notices from the first two parts of the GCN system) from observers about the observations they have made (magnitudes, fluxes, spectra, refined locations, upper limits, etc). I wrote a mail server which validates the incoming reports and distributes them (58 so far) to a list of interested people (>250 so far). GCN occupies about 35% of my time.

InFOCuS project activities:

I continue as instrument scientist for InFOCuS. Work is progressing on the microprocessor development, the flight software, the shield design & procurement, and the housekeeping systems. A second mech. tech has been added to the team (the total list of people I oversee is 1.2 e-techs, 1 mech. eng, 2 mech. techs, and 1 programmer. This is about 30% of my time.

GRB POLARIMETER project activities:

After completing some lab measurements to correlate with the GEANT modeling work (Ben Mazin), the project was put on hold while we look for a "ride" into space. This was about 10% of my time.

LOTIS/Super-LOTIS activities:

I have formed a collaboration with the LOTIS team at LLNL and Clemson U to install the Super-LOTIS instrument (the 3rd generation GRB follow-up instrument) on Kitt Peak (where the my old RMT instrument is currently resting quietly). A recent trip to

Kitt Peak to meet the principle players has solidified this effort. First light will be late-Fall or Winter. This is about 10% of my time.

GTOTE project activities:

This project has been in a period of zero activity. Although it may end up as part of a Super-LOTIS system described above.

CZT Detector Development & the SWIFT MidEx Proposal:

Our group lost the SMEX AO. We are now working towards a new design involving 2 foreign collaborators and 2 US university groups. This is also a GRB mission and will be proposed for the upcoming MidEx AO. I am responsible the mounting design and vibration & thermal testing of the CZT detectors and the front-end electronics. We just finished the first flight-like module and electrical & x-ray testing has begun. I supervise 2 e-tech and 1 e eng on this effort. I spend about 50% of my time on this effort.

## **Task 5030/93-10-00 – TGRS/WIND**

### **David Palmer:**

For the past six months, I have been working on: 1) development for our next Medium Explorer (MIDEX) proposal, 2) Gamma-ray burst (GRB) timing with the NEAR spacecraft, 3) characterizing some anomalies in the Transient Gamma Ray Spectrometer (TGRS), 4) Gamma-ray burst spectral analysis, and 5) educational activities.

1) Development of the next MIDEX Proposal.

Our group will be proposing a GRB instrument which consists of a coded aperture wide-field gamma ray burst telescope, and additional instruments which will be repointed towards a burst when one is detected.

This new instrument (called Swift) uses either CdZnTe or CdTe detectors arranged in a mosaic of about 30,000 detectors with 4 mm resolution. (Our previous proposal used a smaller area of CdZnTe detectors with strips applied to give 0.03 mm resolution). This detector array will be combined with a coded aperture mask to produce images with  $\sim 1/3$  degree resolution.

I have been working on the design this instrument. A prototype detector module (128 detectors) has been built and checked out, and over the next weeks I will be using it with a coded aperture mask to make an image and test the system.

2) The Near Earth Asteroid Rendezvous (NEAR) mission is a spacecraft which will be going out to visit an asteroid. After launch, it was realized that one of the instruments on the spacecraft could be used as a gamma-ray burst detector. I helped specify the behavior that the software modifications should have to let the instrument work in this mode.

The instrument is not turned on all the time during cruise phase (on its way to the asteroid). However, last December and January it was turned on. There were several bright gamma-ray bursts and solar flares in that time period. By comparing the times the gamma-rays hit NEAR and other spacecraft, I was able to determine that there was about a 13 second error in the spacecraft clock. This error has now been corrected, and NEAR will now be able to time gamma-ray bursts. This will allow the interplanetary network (consisting of NEAR, Ulysses, and spacecraft in orbit around Earth) to determine GRB locations to within a few square arcminutes.

3) TGRS, a high-resolution germanium spectrometer for studying GRBs, has been in deteriorating health since November. What had been sharp, narrow lines in the spectra have deteriorated to broad double-humped structures. We believe this is due to the radiation



damage in the detector. This month (April) we are sending commands to alter the high-voltage bias on the detector. This is risky because if the bias gets too high, the current driven by more than 2000 volts can break through the detector and fry the pre-amp. The results so far have been encouraging, and I will send more commands over the next few days. (Right now, there is a proton storm from a solar flare hitting the detector, so we would not get useful data, and would not be able to tell if something went wrong.)

- 4) Since February 1997, the GRB field has been revolutionized by the discovery of counterparts to GRBs in the X-ray, optical, and radio wavelengths. Some GRBs have optical counterparts, some don't, indicating that the ratio of optical to gamma-ray fluxes ranges over at least three orders of magnitude. Only two radio counterparts have been seen, but they also seem to have a large variety of strengths.

I have been looking at the spectra of GRBs with and without detectable counterparts to see if the gamma-ray spectra can distinguish between them. (If the probability of seeing a counterpart can be determined from the gamma-rays, that would allow astronomers to concentrate their efforts on the most likely GRBs). So far, there seem to be no distinguishing characteristics.

- 5) On the educational front, I have been part of the George Washington University tag-team course. I have been a hot-seater (person who answers questions) several times for the "Ask A NASA Scientist" web site.

[http://imagine.gsfc.nasa.gov/docs/ask\\_astro/ask\\_an\\_astronomer.html](http://imagine.gsfc.nasa.gov/docs/ask_astro/ask_an_astronomer.html) I have given talks about gamma ray bursts at Dominion Astrophysical Observatory (Victoria, Canada) Simon Fraser University (near Vancouver, Canada), Yale, and Los Alamos.

**Task 5030/93-11-00 – HE Cosmic Rays**

**John Mitchell:**

During this reporting period, my main activities centered on the ISOMAX balloon program, the PAMELA satellite experiment, and focal plane photon detectors for OWL.

ISOMAX - Isotope Magnet Experiment: The bulk of my activities during the past six months centered on ISOMAX, for which I am Instrument Manager. I am responsible for ISOMAX systems engineering and for directing all aspects of ISOMAX instrument development in addition to having many specific responsibilities.

One of the major hurdles in ISOMAX development has been the superconducting magnet, for which I was responsible. I worked extensively with Oxford Instruments, the manufacturer of the magnet, to insure that it would work successfully. During the past six months, I coordinated final assembly tests in England. My efforts included work on helping Oxford develop expertise in welding aluminum, actual testing of the electrical circuits of the magnet, and consultation on the engineering magnet systems and of the helium and vacuum vessels. As a result, the magnet was successfully completed. It has failed to meet its magnetic field and lifetime (cryogen hold time) goals although there is some hope that the performance can be improved later. However, its current performance is more than adequate to meet the initial requirements of ISOMAX.

The magnet was delivered in January 1998, and I carried out a month long series of acceptance and development testing at GSFC and the magnet has been accepted by GSFC for use in ISOMAX. Among other results, I was able to operate the magnet successfully at fields well above what had been achieved by Oxford and in a more stable manner. In the process, I discovered a number of manufacturing and operational mistakes which Oxford had made. Some of these I was able to correct. Others I have had to develop methods to work around.

In parallel with the magnet testing, the ISOMAX detector and electronics system was integrated and tested using cosmic-ray muons. I was deeply involved in all aspects of this work. The tests were very successful and gave every indication that the ISOMAX detector and electronics systems would meet or exceed their design goals.

Following magnet and detector testing, we began integrating the magnet with the instrument. This involved first integrating the magnet and the main instrument frame and then integrating the resulting unit with the drift chamber tracking system. This was the

most delicate and demanding portion of the instrument build-up. This work was completed by the end of 3/98.

I am responsible for the time-of-flight system and the experiment electronics on ISOMAX as well as for the general instrument technical and functional design. During the past six months, I have worked on the installation and testing of both of these systems including some re-design of the trigger logic to enhance its capability.

ISOMAX activities will occupy virtually all of my time during the next six months. These activities include final integration and testing of the instrument and the first ISOMAX flight to take place in 7/98 or early 8/98. I will also have a leading role in preparing the ISOMAX renewal proposal to NASA.

IMAX (Isotope Matter-Antimatter eXperiment) - This instrument was built and flown by GSFC, Caltech, NMSU, and the University of Siegen (Germany). This is the first experiment to conclusively identify a substantial number of cosmic ray antiprotons by resolved mass. In addition, the light nuclear isotope identification is excellent.

During the past six months, I continued to be closely involved in the data analysis and in publication activities. We are working on a full publication of the IMAX antiproton results and a paper on the proton and helium elemental spectra. I have also worked on a NIM article describing the instrument.

E896 (H0): This is an experiment to search for the H0 dibaryon. The H0 is a six quark MIT bag (uuddss) that is predicted to be produced in great numbers in heavy-ion central collisions. The E896 experiment will conduct the most sensitive search to date for this particle. I am Institutional Principal Investigator on this program and have overall responsibility for the experiment electronics, including the fast event trigger, and for the high-rate beam detector system.

During the past six months, I participated in E896 analysis activities and prepared for the next E896 heavy-ion run, to take place in 4/98. I traveled to BNL for an E896 collaboration meeting in early 3/98 and returned in late 3/98 to begin run preparations. Also, during 3/98 I checked out the E896 centrality detector system which I had constructed and verified that it was in good shape for the run.

PAMELA, is an Italian led experiment to conduct measurements of cosmic ray positrons, electrons, and antiprotons using a moderate-sized permanent magnet spectrometer. In December, 1997, I participated in a PAMELA planning meeting at the University of

ROMA-II in Rome, Italy. This meeting included collaborators from Russia, Germany, the US, and Italy. I am on the technical and physics governing boards of the collaboration. I am the chair of the trigger subcommittee, and have a lead role in development of the time-of-flight, trigger, and TOF electronics systems.

During the past six months, I continued to work on the TOF design and on initial prototype tests. During the next six months, I expect this work as well as work on the PAMELA TOF and trigger electronics to continue.

The new NASA mission-of-opportunity funding attached to the Explorer program presents the first viable opportunity to apply for significant US funding for PAMELA. During the past six months, I helped prepare a proposal to NASA for a mission-of-opportunity under the UNEX AO. A PAMELA proposal will be submitted to the Midex AO in 8/98 as well.

OWL (Orbiting Array of Wide-Angle Light Collectors)- During the past six months I worked on a number of aspects of this new experiment to measure ultra-high energy cosmic rays using a space- based detector looking at particle showers in the Earth's atmosphere.

I have the lead role in the development of the focal plane detector array and detector electronics for this experiment. As a part of this work, I presented a paper in November 1997, at the "Observing Giant Air Showers from Space" workshop held at the University of Maryland. I have submitted this paper for publication.

MASS/WiZard: The WiZard-Related Balloon Program is conducted by an international collaboration with researchers from the U.S. (NMSU and GSFC), Italy, Germany, Sweden, India, and Russia. My responsibilities in this experiment are the time-of-flight system and the trigger electronics.

During the past six months, I worked on a variety of activities, including testing and selection of flight electronics in support of CAPRICE 98. The instrument was shipped to Ft. Sumner, NM in 3/98.

USRA Activities: During the past six months, I continued as the Code 661 Group Leader.

Papers Submitted for publication in last six months:

1998 - "Photodetectors for OWL", J. W. Mitchell, Conference Proceedings, AIP, "Observing Giant Air Showers from Space".

1998 - "Neutron production from the  $40\text{Ca}+\text{H}$  Reaction at  $E_{\text{lab}} = 357\text{A}$  and  $565\text{A MeV}$ ", A. Insolia, C. Tuv, S. Albergo, D. Boemi, Z. Caccia, C.-X. Chen, S. Costa, H.J. Crawford, M. Cronqvist, J.

Engelage, P. Ferrando, L. Greiner, T. G. Guzik, C.N. Knott, P.J. Lindstrom, J. W. Mitchell, R. Potenza, S. Reito, J. Romanski, G.V. Russo, A. Soutoul, O. Testard, C. E. Tull, C. J. Waddington, W.R. Webber, and J.P. Wefel, Adv. Nucl. Dynamics (submitted).

1998 - "Measurement of Low-Energy Cosmic-Ray Antiprotons at Solar Minimum," H. Matsunaga, S. Orito, H. Matsumoto, K. Yoshimura, A. Moiseev, K. Anraku, R. Golden, M. Imori, Y. Makida, J. Mitchell, M. Motoki, J. Nishimura, M. Nozaki, J. Ormes, T. Sacki, T. Sanuki, R. Streitmatter, J. Suzuki, K. Tanaka, I. Ueda, N. Yajima, T. Yamagami, A. Yamamoto, and T. Yoshida, Phys. Rev. Letters (submitted).

1998 - "Large-Area Scintillating-Fiber Time-of-Flight/Hodoscope Detectors for Particle Astrophysics Experiments", D. J. Lawrence, L.M. Barbier, J. J. Beatty, W. R. Binns, E. R. Christian, D. J. Crary, D. J. Ficenec, P. L. Hink, J. Klarmann, K. E. Krombel, J.W. Mitchell, B.F. Rauch, S. H. Sposato, R. E. Streitmatter, and C. J. Waddington, NIM (submitted).

1997 - "Momentum spectra of atmospheric pions, muons, electrons and positrons at balloon altitudes," A. Codino, M. T. Brunetti, C. Federico, C. Grimani, M. Lanfranchi, M. Menichelli, M. Miozza, R. L. Golden, S.J. Stochaj, S. A. Stephens, J.W. Mitchell, J. F. Ormes, R. E. Streitmatter, M. Hof, C. Pfeifer, W. Menn, M. Simon, G. Basini, M. Ricci, F. M. Brancaccio, P. Papini, S. Piccardi, P. Spillantini, M. P. DePascale, A. Morselli, P. Picozza, J. PHYS. G23, 1751.

## **Task 5030/93-12-00 – EGRET**

**Joseph A. Esposito:**

### **I. - EGRET:**

1. Continued maintenance of the EGRET Maximum Likelihood Analysis Software (LAS). Due to user requests for upgrades and adapting the program for use in generating the 3rd EGRET High Energy Gamma-Ray Catalog, this task averages at roughly 10%-15% of my time. This includes time spent in creating the WebSite Based on-line Users Guide.

LAS Users Guide URL:

<http://heawww.gsfc.nasa.gov/users/jae/like/>

2. I completed my assigned cycle 7 viewing period analysis and turned in a full observation report to the EGRET team.

3. I continued analysis of archive EGRET data pertaining to gamma-ray emission from supernova remnants. New observations continue to be included in the data set however, few EGRET observations near SNRs occur which limits improvement in determining spectra. This work was last presented at the AAS HEAD meeting in Estes Park, CO, during November, 1997, and falls under an approved CGRO cycle 7 proposal (GRO-97-242) which was submitted for continuance in the CGRO cycle 8 proposal with myself as PI. This work consumes roughly half of my 25% personal research time.

4. I continued analysis of archival EGRET data pertaining to gamma ray emission from starburst galaxies in collaboration with Dr. Giovanni G. Fazio of CFA. This work was presented at the 191st meeting of the AAS in Washington, DC, during. This work is still on-going as an awarded CGRO cycle 7 proposal (GRO-97-260) with myself as PI. This work consumes a minor portion (an average of roughly 1%) of my 25% personal research time.

5. Data analysis on the EGRET in-flight calibration has been restarted since January, 1998 at roughly 50%-60% time. This includes developing a new data analysis tool (bootstrap sampling of EGRET data) in order to ascertain the instrumental performance. As of 31 March 1998, the Galactic anti-center data for viewing period vp0010,  $E > 100$  MeV, has been analyzed for fixed sources. The results indicate that the EGRET point source intensity resolution, from the bootstrap sampling analysis, is consistent with results from the 3EG catalog (3rd catalog) for strong

sources (e.g. Geminga, Crab, 0528 and IC443) and that the intensity resolution falls off as expected as the source strength weakens. This analysis is on-going and has been extended to permit the source location to wander to the optimum location. The latter will yield results pertaining to the EGRET point source position resolution. The results of this work is part of the EGRET in-flight calibration effort (analysis and publication writing are under my direction) which will be re-submitted for publication during the 01 April-30 September period with myself as lead author.

## II. SRT Research:

1. My commitment to SRT laboratory research continued until 01 January 1998, with WebSite maintenance continuing to present. My work during the 30 September-01 January period was primarily concerned with WebSite development, laboratory work pertaining to deposition of a gold layer on kapton film, programmatic meetings and reports and assisting with other parts of the Gas Micro-Structure Detector project as needed. This work comprised 50%-70% of my time (average at roughly 60%). Current WebSite maintenance time is currently 0%. GMSD URL: <http://lheawww.gsfc.nasa.gov/users/jae/GMSD/>

## III. Public Outreach and Education:

1. I have become an active member of the Ask a NASA Scientist WebSite response team. This activity requires roughly 15 hours every 4-6 weeks. During March I "sat hotseat" (responded to questions) for the first time.
2. I have continued volunteer as judge for elementary school science fairs whenever it is possible and made presentations to two classes at Hebron High School in Howard County for National Engineering Week.
3. I am in the process of developing a Space Science Education WebSite under my personal, non-GSFC, WWW space provided by my ISP. This site will provide links for students, teachers, and anyone who is interested to Astronomy WebSites (e.g. "Imagine the Universe" and "Starchild" for students; HEASARC image directories for interesting pictures of planets, galaxies, and nebula) and a direct link to "Ask a NASA Scientist". This is unfunded work and is being done on personal time at personal expense as a courtesy to the teachers and children who are fascinated, as I, by astronomy. This WebSite will never promote individual products and will function under the same rules as a non-profit organization. Donated funding

to defray the minor ISP costs (total ~\$42/mo) is welcome.  
URL: <http://members.home.net/jae/>

#### IV. GSFC Activities:

1. I contribute approximately 15 hours per week of personal (evening) time to WebSite maintenance of the GEWA sponsored Goddard Slow Pitch Softball League. This work provides a test bed for CGI programming that I use for the other gamma-ray group WebSites I maintain. GSPSA URL: <http://lheawww.gsfc.nasa.gov/users/jae/GSPSA98/>

#### V. Programmatic:

1. Programmatics (e.g. proposal writing, meetings, reports, etc.) continue to take roughly 5%-10% of my time with peaks as high as ~100% near proposal due dates. Reading and responding to daily Email requires an additional 5% time (roughly 2.5 hrs per week).

2. Attendance at local scientific seminars and colloquia, and reading current publications at the library comprise about 5%-10% of personal research time. Additional time is used to keep up with current trends in instrumentation, computers and software, and to learn new programming languages and tools. This latter work is primarily performed during my off work, personal, time.

#### VI. Curricula Vitae:

1. My current CV and publications list is on-line. URL: <http://members.home.net/jae/CV/>
2. All WebSites can be linked to from URL: <http://members.home.net/jae/>



## Task 5030/93-12-00 - EGRET

### **P. Sreekumar:**

A significant part of the last 6 months was utilized to wrap up the revised long term sensitivity correction factors for the EGRET instrument. The spark chamber gas in EGRET has been found to degrade with use and it was important to determine if adjustments to the currently applied correction factors (its absolute value as well as its energy-dependence) are necessary for data acquired since the end of 1995. Based on the revised correction factors all standard EGRET skymaps are being recreated at present. The determination of the new correction factors were carried out using a new approach where the maximum likelihood technique is applied to the current data using the corrected early allsky data as a standard. This approach yields facets consistent with those determined previously for the early datasets. The more recent observations which yield a smaller sky region and fewer photons due to the poor instrument capabilities, are better evaluated using the new maximum likelihood analysis. Other routine activities include carrying out QUICKLOOK analysis of EGRET data during on-going observations.

I have assisted the team lead by R. Hartman to putting together the 3<sup>rd</sup> EGRET source catalog that is about to be submitted to the Astrophysical Journal Supplement. I was involved with the analysis of CenA data, Mrk501 data and the  $E > 10$  GeV spectra of gamma-ray blazars.

Interaction with collaborators from the Univ. of New Hampshire (who are also Guest Investigators on the CGRO program) in examining the emission from BL Lac object 2155-304.

### **Meetings attended:**

A paper on the detection of the first radio Galaxy, CenA by EGRET was presented at the AAS meeting in Washington DC (Jan 1998).

A paper on the  $> 10$  GeV spectra of the strongest AGN was presented at the HEAD meeting, Estes Park in November 1997.

An IAU circular on the flaring state of PKS 2155-304 was mailed out in November (Sreekumar and Vestrand, IAUC 6774)

**Task 5030/93-13-00 – Theory**

**Xin-Min Hua:**

Research on high-energy solar physics and astrophysics.

Papers Published, Accepted or Prepared for Publication:

- 1) “Monte Carlo Simulation of Comptonization in Inhomogeneous Media”, X.-M. Hua, Nov/Dec 1997, Computers in Physics, Vol. 11, No. 6, p.660.
- 2) “The Time Duration-Energy Relation of Gamma Ray Burst and Its Interpretations”, D. Kazanas, L. Titarchuk, and X.-M. Hua, 1998, Astrophysical Journal, 493, 708.
- 3) “Timing Noise Properties of GRO J0422+32”, G.E. Grove, R.A. Kroeger, S.M. Matz, X.-M. Hua, D. Kazanas and L. Titarchuk, 1998, in press, Astrophysical Journal.
- 4) “Frequency Dependent Hard X-Ray Lag - A Common Property of Accreting Sources”, X.-M. Hua, D. Kazanas and W. Cui, 1998, Submitted to Monthly Notice of Royal Astronomical Society.
- 5) “Surprisingly Intense Neutron Emission from a Flare Behind the Limb of the Sun”, R. J. Murphy, G.H. Share, K.W. DelSignore and X.-M. Hua, 1998, submitted to Astrophysical Journal.
- 6) “Modeling the Time Variability of Black Hole Candidates”, D. Kazanas and X.-M. Hua, 1998 Submitted to Astrophysical Journal.

## **Task 5030/93-13-00 – Theory**

### **Natalie Mandzhavidze:**

In December 1997 I visited UNAM, Mexico City, where I was invited to give two seminars and a General Scientific Colloquium.

In March 1998 I gave two seminars here at Goddard entitled 'Gamma Ray Emission from Solar Flares: Elemental Abundances at the Sun and Beyond'. One was at the general LHEA seminar, another one at the seminar of the Interplanetary Physics Branch of LEP.

A paper 'Solar Atmospheric and Solar Flare Accelerated Helium Abundance >From Gamma-Ray Spectroscopy' by N. Mandzhavidze, R. Ramaty and B. Kozlovsky was published in ApJ Letters (1997, 489, L99).

Currently we are working on the interpretation of the gamma ray line data obtained with CGRO/OSSE. Earlier we have shown that the large alpha-alpha line fluxes observed with SMM/GRS from a number of flares imply that either the accelerated alpha particle to proton ratio ( $\alpha/p$ ), or the ambient He/H, or both, are significantly higher than the standard value of about 0.1. Both have very serious implications, high  $\alpha/p$  - for the understanding of particle acceleration mechanism, high He/H - for the understanding of solar atmospheric dynamics. While the SMM data did not allow us to distinguish between the two possibilities, using the more precise OSSE data we now find that  $\text{He}/\text{H} > 0.1$  independent of the  $\alpha/p$  value.

We calculate the amount of Li that is produced in the nuclear interactions of the flare-accelerated particles with the ambient solar atmosphere. Our preliminary estimates show that it is sufficiently high to be observed with the ground based optical telescopes. Such observations will provide unique opportunity of optically imaging the nuclear interaction site of flare accelerated particles and will provide information on the processes of material mixing and diffusion in the solar atmosphere.

We plan to collaborate with Dr. J. Miller (UNH) and Dr. Adolfo Vinas, (GSFC) on theoretical interpretation of the time dependence of heavy element abundance enhancements that we found from the analysis of the PHEBUS/ GRANAT gamma ray data.

## **Task 5030/93-14-00 Mirror Development**

**Kai-wing Chan:**

In this report, my work on the development of X-ray telescopes for project ASTRO-E is summarized, and the general development of the telescopes for ASTRO-E is described. The ASTRO-E mirror team consists of the following scientists: Dr. P. J. Serlemitsos with GSFC, Dr. Yasushi Ogasaka with Japan Society for Promotion of Science, Drs. Wilhelm Mandl, Yang Soong and myself, all with USRA. Dr. Ogasaka finished his 2-year term by March and has left us at the end of March. Dr. Mandl has just joined us since February.

In the following, I will briefly summarize the status of ASTRO-E mirrors from October 1997 to March 1998. Much of the work is not done by a single person, but I will try to delineate my contribution to them from my own point of view.

(Besides work on ASTRO-E, I have also engaged in development of new foil mirrors. I have been working with Robert Petre of the X-ray branch, David Content and Timo Saha of the optical design section to find new ways of making more precise mirrors. Wilhelm Mandl and myself are also performing various calculation and ray-tracing to pinpoint the dominant errors if we are to achieve much more precise mirrors. These work are still in progress and will not be described here.)

Development of ASTRO-E telescope (in approximately chronological order):

As of October 1997, the basic research concerning the production of ASTRO-E foil reflectors are completed, and we were engaging in full production of the reflectors. Yang Soong and myself shared the responsibility of overseeing the production. The task includes any possible fine adjustment of fabrication process and quality control. I concentrate more on the quality control and metrology.

Since then, we have stepped up the production rate by 17%, to 21 reflectors a day. This allows us to finish all the reflectors, at the current rate, by November 1998--somewhat ahead of schedule.

The effort then was shifted to testing the reflectors in the telescope housing. From previous studies, it was found that in order to improve the stability of the image with respect to orientation of the telescope, we need to tighten the width of the grooves of the alignment bars in order to reduce the extra freedom between the reflectors and the telescope housing. We ordered new sets of hardware with about 25

micrometers reduction in the groove width of alignment bars.

However, we soon found that the interaction of alignment bars with the foil reflectors are more subtle than we expected, and the image of the telescope (we were testing only a quadrant of the full telescope) was not good. The means which we planned to adjust for the excess freedom does not improve the situation. Peter Serlemitsos, Yang Soong and myself did numerous experiments with the alignment bars and the reflectors, but the result is not promising. We have a resolution of about 1.7 to 1.8 minutes of arc, which is, even though nearly a factor of two better than that of ASCA, substantially far from our target of 1.0 minute of arc.

It was found that the problem is largely due to the non-uniformity of the thickness of the reflector at the edges. These non-uniformities arise from the small distortion of foil when they are heat-formed. These distortion has long been known and are limited to 15 micrometers in our quality control processes. Such magnitude was acceptable from previous test. However, the tighter grooves of the alignment bars apparently call for a more uniform reflector edge.

We delivered the first telescope on 23 December, 1997, with a resolution of about 1.8 minutes of arc for the four quadrants.

The test done in Japan showed a resolution of about 2.0 minutes of arc. This possibly is a more realistic number since it is not possible to test the outer part of the telescope in X-ray at GSFC, due to the limitation of our X-ray beam size.

In March, vibration test was carried out in Japan on the first telescope. The result was DISASTROUS: (a) a few screws in the inner part of the telescope actually came loose, and in addition, (b) some of the foils in the telescope jumped out of the alignment bar grooves. Even though we do not directly work on the telescope's structural design, it is ultimately our responsibility that the structure is not adequate.

Problem (a) might not happen had the telescope's screws been fully epoxy-staked in Japan, as was specified, before the telescope was subjected to full-level vibration. All the screws that has come loose are those that has not been

staked. Even though, with all fairness, the screws should not have come loose even without the epoxy-staking.

Problem (b) is a more serious problem. The bending of the alignment bars (there are 208 of them in the telescope housing, each individually tuned to guide the 1400 reflectors to focus) in full level random vibration were found to be too marginal, occasionally exceeding the allowable limit to keep the reflectors in place.

Schedule was immediately made to conduct similar vibration test here at GSFC. The test was scheduled on April 9. At the time of writing (April 24), the test is essentially completed. Even though this is beyond the period of concern for this report, I include a brief update here for completeness.

The vibration test is done on the second telescope scheduled to be delivered to Japan in April. The 2-week long test actually started on April 13. The ASTRO-E mirror team, which includes our lab manager Curtis Odell, vibration and structural engineers from GSFC, structural analysts who design the telescope housing, and Drs. H. Kunieda and M. Ishida from Japan, participate in the test. The result so far is very encouraging. (a) We staked all the screws with epoxy before the telescope is subjected to vibration. The result is that all the screws are intact after the telescope went through acceptance level shock tests in z-direction, full level random vibration test in x, y and z directions, and qualification level shock test in x and y directions. (b) We have applied maximum torque to essentially all the screws of the telescope assembly, including all the alignment bar screws, before sending it to the vibration facility. The resulting magnitude of bending of the alignment bars was found to be approximately 60% of the limit value at maximum bending, from strain gauges measurement (11 channels), laser micrometers (1 channel), accelerometers (21 channels) and laser vibrometer (1 channel).

So, it seems safe to say now that the telescope is structurally robust (and without damaging effect on the telescopic performance) with proper epoxy staking and torque applied to the screws. I have followed the whole process through and reported to project P.I. Peter Serlemitsos timely from the vibration facility. I was responsible for the telescope assembly as well as optical white light test of image integrity between various vibrations, which were done alternatively in buildings 2

and 7 and on tight time limits. Wilhelm Mandl worked with me on both the assembly and the white light tests. At the time of writing, all the vibration tests are completed and the final white light assessment will be done (after I finished this report.)

On the other front, progress has also been made recently. In order to reduce the edge bending of the foil reflectors, Peter Serlemitos proposed to try new aluminum alloy rather than the essentially pure aluminum we have been using for our base substrate. (Even though it may seem late to change---we have already fabricated enough foils for 3 of our 5 telescopes---we decided that it is an idea worthy of serious experimentation.) Peter found a suitable heat-treatable aluminum alloy and we ran our first test in March. The result is better than we anticipate. On our first test, the edge bending was reduced to 1-3 micrometers---negligible in our case---and the first x-ray image on 5 pairs of reflectors already showed a 1.2 arc minute angular resolution.

We have planned more experiments on the new alloy. At any rate, we have since started our full production on foil forming with the new alloy on April 13. The full replication with the new alloy is now scheduled at the end of May.

To summarize:

1. We have delivered the first telescope, on schedule, but with mediocre resolution.
2. The first telescope has structural problems when tested in Japan.
3. We have tested the telescope at GSFC with all the screws properly torqued and staked. The result is good.
4. We have begun to use a new aluminum alloy which improve significantly on the performance of the foil reflectors.

Publication:

“Hard X-ray Focusing Telescope---The New Era of Supermirror Optics” by Koujun Yamashita, Peter J. Serlemitos, Jack Tueller, Scott D. Barthelmy, Kai-Wing Chan, Kazutoshi Haga, Hideyo Kunieda, Gyanendra Lodha, Norio Nakajo, Yoshiharu Namba, Yasushi Ogasaka, Yang Soong, Carl M. Stahl, Keisuke Tamura, Yuzuru Tawara. Submitted to Applied Optics.

### Task 5030/93-14-00 – Mirror Development

#### **Yang Soong:**

During this period, we have assembled and delivered two telescopes out of the designated five, and a single quadrant was also delivered to serve as an engineering model. The quadrant was tested in Japan, and it survived the vibration test structurally. The first telescope also went through a similar test, but due to certain human errors, it was disqualified, namely the structural integrity was in question. Because of that, the second telescope was qualified at GSFC while our Japanese counterpart was invited here to work together and to observe the outcome of the test. Fortunately, it survived the test so that we can put the doubt to rest. Currently, we are working on the third telescope assembly, and hope to understand the image formation better in order to achieve the quality that we have suggested few years ago.

A German scientist, Dr. Wilhelm Mandl, joined the group early February to participate the further advancement of the X-ray optics. Currently, we are working on two major fronts, namely, image quality improvement and broaden the energy band from current 1 minute of arc to 1/4 minute of arc and from up to 10 keV to 40 keV, respectively.

We have high hope to continue the group tradition into the next millenium to provide the high quality X-ray optics to the physics community.



## **Task 5030/93-20-00 – CGROSSC**

**Paul Barrett:**

### **A. Programmatic Work**

#### **1. COMPTel Archive**

About 30% of my time during the last 6 months has been spent developing the COMPTel pipeline software to archive the COMPTel data in both native and FITS format. All native data was ingested into the archive by late January 1998. Since then I have worked to develop the software to convert the native data to FITS format.

Example FITS files were submitted to the OGIP FITS working group at the beginning of April. A completion date for the archiving of the FITS files is scheduled for 1998 May 1.

Completion date for the documentation of this work is scheduled for 1998 June 1.

#### **2. COMPASS (COMPTel Analysis Software System)**

Beginning in early Sept 1997, a plan was implemented to migrate the COMPASS software from the 'cosmic' workstation running SunOS 4.1 to the 'compass' workstation running Solaris 2.5. This migration is not yet complete mainly because more emphasis has been given to developing the COMPTel archive. Once the archive task is nearly complete more emphasis will be given to completing the COMPASS migration. COMPASS is operational. The next step is to verify the software and provide documentation. A completion date for these two tasks is scheduled for 1998 June 1 and Aug 1, resp., with any loose ends to be completed by 1998 Oct 1.

#### **3. GRO Help**

I am still the primary contact for the CGRO helpline. Though requests tend to arrive in groups of 3 or 4, I have on average about 1 request per week.

#### **4. Remote Proposal Submission (RPS)**

Preparation for Cycle 8 of the CGRO NRA was begun in November 1997. A few minor changes were made to the software by late January and tested in early February. Since late February 1998 RPS has been installed and made functional. This system is basically automatic requiring little to no human intervention. As expected, little use of RPS has been made through 1998 March 31.

#### **5. Teaching and Mentoring**

I was one of 8 lectures for the "Introduction to High Energy Astrophysics" course taught at George Washington University during the autumn of 1997.

During January 1998, Sara Mitchell spent two weeks assisting me in a research project on the luminosity function of magnetic cataclysmic variables.

#### 6. Move to Building T2

I moved from Building 1 to Building T2 in late January 1998.

### B. Research Work

#### 1. Soft X-ray Luminosity Function of AM Herculis Binaries.

A paper is still in preparation on this subject. Programmatic activities and proposal writing has limited the time that I am able to spend on this.

#### 2. Identification of 6 White Dwarfs in the ROSAT archive.

A paper describing these results is still in preparation.

#### 3. Optical and radio observations in Australia

Preparations to make simultaneous X-ray and optical observations of quasi-periodic oscillations in AM Herculis stars are progressing. This work is in collaboration with Lilia Ferrario at ANU and Stefan Larsson at Stockholm Obs. In addition, simultaneous radio and optical observations of the 2.2 MeV gamma-ray source, RE0317-854, are in preparation, also with Lilia Ferrario. These observations will be made in late June 1998 at the Siding Spring Observatory and the Australian Telescope Compact Array facility in Australia.

#### 4. SAX and AXAF proposals.

A SAX proposal entitled "The Hard X-ray Luminosity Function of Magnetic Cataclysmic Variables" was rejected. Several proposals were submitted to AXAF of which I was a Co-I.

#### 5. I attend the Python Conference in October 1997, the High Energy Astrophysics Division Meeting in November 1997, and the American Astronomical Society Meeting in January 1998.

**Task 5030/93-20-00 - CGROSSC**

**Jerry Bonnell:**

Performed:

Assisted in Compton GRO data archive effort and responded to BATSE related guest investigator requests.

Supported GLAST instrument simulation effort

Supported GLAST science simulation effort (GRB simulations)

Gave GRB and GLAST related presentations at BATSE Huntsville workshop

Produced video presentations of GLAST simulation results.

Published:

"Brightness-Independent Measurements of Gamma-Ray Burst Durations" ApJ. 490, 79, (November 1997).

"Gamma-ray Bursts of Doom" Feb. 1998 Sky and Telescope cover article.

Planned:

Continue to support CGRO archiving and GLAST simulation efforts.

Continue to work on BATSE Gamma-Ray Bursts.

## Task 5030/93-20-00 - CGROSSC

**W. Thomas Bridgman:**

### Project Support Accomplishments:

There were 11 unallocated observing weeks for OSSE this cycle. As a result, we conducted an unfunded miniproposal cycle for the time. Only one proposal was submitted - Bob Kinzer of NRL, who will use the time as part of an instrument systematics study. I developed a graphical viewing period tool accessible from the CGRO WWW site (<http://coss.c.gsfc.nasa.gov/coss.c>) which enables one to view the spacecraft orientation projected on the sky. This was a more general version of the program used for the miniproposal cycle, where you could enter the coordinates of a source and see if it was on the OSSE scan plane or within the EGRET or CompTel fields-of-view. I staffed the CGRO display booth at the 191st AAS and was there when Dan Goldin walked through on Saturday at lunchtime. I spoke with him for 2-3 minutes, basically emphasizing that CGRO is still performing good science.

The revised OSSE low-level spectral data pipeline is now fundamentally operational. There have been some minor bug fixes and adjustments. I am currently working to make sure this database can be properly interfaced with the W3Browse software. I've also begun work with Mark Strickman of NRL on the OSSE detector response matrix generator FTOOL.

I've had two inquiries on using OSSE data where my assistance was required: one from a student of Edison Liang at Rice University, the other from a researcher working in Japan.

I presented more recent results on my "Temporal properties of Compton Reflection from Accretion Disks" in poster at the 191st AAS. I feel that the level of my programmatic responsibilities has seriously hindered my research work.

### Outreach Activities:

I've answered 5 Ask\_Astro questions (I'm listed as a resource for answering questions on several topics - black holes & relativity) and one question apparently through my STELLAR site (set-up under my IDEA grant). I'm also working with the group developing the LHEA "Black Holes" poster.

### Priorities for the Next Six Months:

My priorities for the next six months include (1) Revised High-Level spectral data pipeline will be going on-line in the next 1-2 weeks. (2) Repair of OSSE low-level pulsar data pipeline. (3) Complete FTOOL to generate OSSE DRM for use by XSPEC.

(4) Completion of answers to referee inquiries on Cygnus X-1 paper. (5) Installation of IGORe v7.5 at COSSC. (6) Support work for Cycle 8 (target validation, peer review & timeline). (7) Revise OSSE Guest Investigator Guide.

#### Odds-n-Ends

Here's a few items that I have been involved with pretty much on my own time, but which have some relevance to the project or astronomy. I'm doing some scientific code development on the Macintosh and was involved in tracking down bug in Macintosh/Metrowerks port of CFITSIO v1.30 with Bruce O'Neel. I assisted Paul Barrett in debugging his Python FITS library. On March 10, I gave talk on CGRO at the Goddard Astronomy Club meeting. Through the Greenbelt Astronomy Club (of which I am currently serving as President) I found myself in a discussion/argument/whatever of astronomy issues with a local 'Creationist'. I regard this issue as important to deal with, as I feel that it is a certain amount of perceived arrogance (justified or unjustified) by the scientific community towards the public (which provides the majority of our funding) that has enabled many who hold these beliefs to move into positions of power over NASA and other science funding.

## **Task 5030/93-20-00 – CGROSSC**

### **Daryl Macomb:**

My support work consisted of the following: Finished planning, implementing, and overseeing the production of the 2nd EGRET CD. This involved finishing up some JAVA programs, writing final documentation, and coordinating artwork etc. This CD was made available at the January AAS meeting. In addition, I have provided help to CGRO SSC personnel regarding EGRET related matters. I also provided EGRET flux information to several guest investigators. I also did some technical writing for some GLAST related reports. I continued to work on some JAVA code and am pursuing a scheme to allow investigators to run EGRET software over the internet. I have a working "server" which allows one to run the LIKE program over the internet and am now working on a JAVA applet as the client side application. Finally, I began work on a new gamma-ray astronomy poster to be ready in time for the Senior Review.

IN the next 6 months, I will complete the LIKE applet, and if it meets expectations make the EGRET spectral program available on the WWW. In addition, now that the GROSSC has finally got the new web server up, I am ready to put the CGI program which allows users to plot EGRET light curves online. I will update this to use the third EGRET catalog when available. I will finish the gamma-ray poster in the next couple months, which is based upon the catalog of Macomb and Gehrels.

In terms of research, I have made progress on six programs:

The first is participation in a project headed by Neil Gehrels to study unidentified gamma-ray sources in the galactic center region. I worked extensively on the archival EGRET data to characterize the quality of purported sources in this region. With access to the coming 3rd EGRET catalog, I will continue this study and look at the variability and spectral characteristics of these sources. I have also made progress on an updated GeV catalog featuring a study of transient GeV sources. There are possibly new sources which have been identified and we are beginning to characterize the variability of sources at GeV energies (co-I R.C. Lamb). With R.C. Lamb and T. Prince (Caltech) I began a program of archival searches for pulsars in the ROSAT database. A trip to Caltech was taken which resulted in good progress on this program, which is to be submitted as an ADP proposal. This work has and continues to involve becoming very familiar with ROSAT data analysis and archives. Work is beginning on automating searches for pulsed emission. Work will continue on all three of these projects. I also did work on a paper submitted to ApJ by Shrader et al. on the gamma-ray source GRO J1008-57.

In addition, I led the analysis and am lead author on a paper submitted to ApJ on the EGRET/XTE detected quasar PKS 2255-282. Finally, I made significant progress on the general gamma-ray source catalog (co-I Gehrels) which is very close to being submitted to ApJ supplements. This work will continue along with efforts to put this catalog online.

## **Task 5030/93-20-00 - CGROSSC**

**Chris R. Shrader:**

USRA/CGRO-SSC & Integral Spectrometer SW development Team:

### **CGRO Guest Investigator Program:**

Preparations are underway for the Cycle-8 peer review. Strategies for optimizing the scientific output of the mission in an environment of shrinking resources were presented to the CGRO Users Committee and discussed.

The CGRO Cycle-8 NRA and appendices were edited, and presented to the Program and Project Scientists. Some significant changes to the program, including the modified use of the EGRET instrument, and some new policy issues such as the proprietary data-rights period and PI Team funding guidelines required major changes to certain portions of the NRA.

Routine Guest Investigator inquiries, too numerous to list, were handled. Subjects included instrumentation technical details, program policies and procedures and the proposal evaluation process.

### **CGRO Project Support:**

The scientific section of the CGRO proposal to the NASA HQ Senior Review Committee is being drafted and will be distributed to the CGRO Users Committee for feedback next month. Strategies for the Senior Review were discussed at a special CGRO Users Committee Meeting during March, 1998.

Various statistics regarding the CGRO Guest Investigator program were supplied upon request to NASA Headquarters and the Project Scientist. Maintenance of the CGRO-SSC GI Program database continued.

### **CGRO-SSC Group Leader Activities:**

Various internal CGRO-SSC organizational meetings were held to coordinate the various ongoing activities. A number of staffing issues were discussed with USRA and GSFC management.

### **Scientific Research:**

Four articles were submitted to scientific journals for publication (two as first author, two as co-author). Topics included X-ray Nova, Be X-ray Transients Quasars.

### **Integral Spectrometer Scientific Software Development:**

Participation in this activity began in mid February 1998. Numerous team meetings were conducted, and a large amount of documentation was assimilated. A plan for modifying the XSPEC



analysis software for use with the Integral Spectrometer (SPI) was developed and discussed with the HEASARC. A series of presentations was made at the SPI collaboration meeting.

Other LHEA Activities:

Activities as co-chair of the Monday seminar series, and as a member of the Tuesday seminar committee meeting were continued.

**Task 5030/93-20-00 - CGROSSC**

**Kenji Watanabe:**

Papers & Conference Participation:

\*Paper: "EXTRAGALACTIC X-RAY BACKGROUND DUE TO COSMOLOGICAL SUPERNOVAE", written by K. Watanabe et al., was submitted and appeared in *Astronomische Nachrichten*, vol. 319, no. 1, p. 67, 1997

\*Paper: "CONSTRAINTS ON COSMIC CHEMICAL EVOLUTION FROM GAMMA-RAY BACKGROUND MEASUREMENT WITH SMM", written by K. Watanabe et al., was submitted to appear in IAU 23rd General Assembly, Symposium 187 Cosmic Chemical Evolution (Kyoto, Japan) Proceedings, 1997, in Press.

\*Abstract: "STUDYING THE HIGH-ENERGY GAMMA-RAY SKY WITH GLAST", written by K. Watanabe and the GLAST Collaboration, was submitted to the 32nd COSPAR Scientific Assembly (July, 98 in Nagoya, Japan).

\*Abstract: "SMM MEASUREMENT OF THE ISOTROPIC GAMMA-RAY BACKGROUND", written by K. Watanabe et al., was submitted to the 3rd INTEGRAL Workshop (September, 98 in Sicily, Italy).

\*Abstract: "THE CONTRIBUTION OF SUPERNOVAE TO THE COSMOLOGICAL MEV GAMMA-RAY BACKGROUND", written by K. Watanabe et al., was submitted to the 192nd Meeting of the AAS (June, 98 in San Diego).

Other research:

\*Attended the RXTE Guest Observer Facility training session to analyze GX5-1 data. (For XTE proposal: "TESTING THE BEAT FREQUENCY MODEL OF HORIZONTAL BRANCH QPOS", PI: P. Hertz, Co-Is: J. Norris, K. Wood, J. Scargle and K. Watanabe)

\*Finished the GREET (Gamma-Ray Extended Emission Telescope) proposal for NASA's UNEX (UNiversity-class EXplorers) program. (PI: M. Leventhal, Co-Is: S. Barthelmy, L. Cheng, N. Gehrels, R. Kroeger, J. Naya, M. Strickman, B. Teegarden, J. Tueller and K. Watanabe) (submitted April, 6, 1998)

Outreach:

\*Attended "The Cosmos in the Classroom: Getting Involved in Education and Outreach" workshop-Compton GRO Science Support Center (COSSC)

\*The BATSE Earth Occultation light curves on the BATSE web pages were adopted by Ian Smith (ian@spacsun.rice.edu) for his paper.

\*A complete set of the 4th BATSE Burst Catalog was made on the BATSE web pages at  
<http://cosscc.gsfc.nasa.gov/cosscc/BATSE.html>.

\*Attended the 191st Meeting of the AAS in DC as an exhibitor of the CGRO booth.

\*Started making a FTOOLS for the BATSE occultation spectrum.

\*Started electrical delivery of the BATSE trigger data & daily data from MSFC.

Plans for the next 6 months:

-Conference Participation & Contributions

\*The 192nd Meeting of the AAS (June, 98 in San Diego)

\*Nuclei in the Cosmos (July, 98 in Volos, Greece)

\*The 32nd COSPAR Scientific Assembly (July, 98 in Nagoya, Japan)

\*The 3rd INTEGRAL Workshop (September, 98 in Sicily, Italy)

-Papers & Research:

\*Paper: "The Cosmic Gamma-ray Background due to Cosmological Supernovae", written by K. Watanabe et al., will be submitted to ApJ

\*Analyzing the XTE GX5-1 data

\*Finishing up the SMM cosmic gamma-ray background research

\*Starting the OSSE cosmic gamma-ray background research

-COSSC

\*Improving the BATSE pipeline

\*Making more FTOOLS for the BATSE data

\*Adding more analysis tools with WWW-IDL interface for the Earth occultation data and others

## **Task 5030/94-07-00 – XTE-SOF**

### **Robin Corbet:**

XTE SOF - A primary task during this period was to achieve reductions in the staffing levels in line with budget reductions.

This has been achieved successfully and the SOF operations staff now consists of 6 full-time people. - A 50% reduction from the peak level of 12. This reduction has been achieved with only a relatively modest impact on the performance of scientific operations. During unstaffed periods software monitors instrument performance etc. and automatically pages relevant SOF staff if a problem is detected.

During this period we also transitioned to carrying out the third round of XTE proposals (AO3) and this is now fully in progress.

SWIFT - I am also undertaking some simulations of observation strategies for a possible future Gamma-ray burst mission which is headed by N. Gehrels and N. White.

Miscellaneous: During this period I also refereed papers for "The Astrophysical Journal" and "Monthly Notices of the Royal Astronomical Society."

### **Scientific Research**

#### **Refereed Papers:**

"A multi-wavelength campaign on gamma-Cas. I. The case for surface X-ray flaring," M.A. Smith, R. D. Robinson, & R. H. D. Corbet, 1998, *Astrophys. J.*, in press.

"X-rays from gamma Cassiopeiae with ASCA," S. Kubo, T. Murakami, M. Ishida, & R. H. D. Corbet, 1998, *PASJ*, submitted.

#### **Previously submitted and now published:**

"RXTE observations of the Be star X-ray transient X0726-260 (4U0728-25) - Orbital and Pulse Periods", R.H.D. Corbet & A.G. Peele, 1997, *Astrophys. J. Letters*, 489, L83.

#### **Contributed Papers/Published Abstracts:**

"RXTE quick response observations of afterglows from GRBs", T. Takeshima, F. Marshall, A. Valinia, J. Swank, R. Corbet, & C. Robinson. 4th Huntsville Gamma-ray Burst Symposium, September 1997.

"RXTE ASM observations of X0114+650 (2S0114+650)", R.H.D. Corbet, J.P. Finley, & A.G. Peele, 1998, *BAAS*.

"The case for X-ray flaring in gamma Cas", M.A. Smith, R. D. Robinson, & R.H.D. Corbet, 1998, *BAAS*.

"RXTE observations of gamma-ray burst afterglows", F. Marshall, R. Corbet, T. Takeshima, S. Barthelmy, R. Kippen, G. Pendleton, R. Preece, V. Connaughton, & K. Hurley, 1998, *BAAS*.

### **IAU Circulars**

"GRB 970828", F.E. Marshall, J.K. Cannizzo, & R.H.D. Corbet, 1997, *IAUC* 6727.

“GRB 970828”, T. Murakami, Y. Ueda, M. Ozaki, A. Yoshida, N. Kawai, F.E. Marshall, R. H. D. Corbet, & T. Takeshima, 1997, IAUC 6729.

“GRB 970828”, T. Murakami, Y. Ueda, A. Yoshida, N. Kawai, F.E. Marshall, R. H. D. Corbet, & T. Takeshima, 1997, IAUC 6732.

“XTE J0053-724”, R. Corbet, F.E. Marshall, J.C. Lochner, M. Ozaki, & Y. Ueda, 1997, IAUC 6788.

“XTE J0053-724 and AX J0051-722”, R. Corbet, F.E. Marshall, J.C. Lochner, M. Ozaki, & Y. Ueda, 1998, IAUC 6803.

“XTE J0055-724 = 1SAX J0054.9-7226”, A. Santangelo, G. Cusumano, G. L. Israel, D. Dal Fiume, M. Orlandini, F. Frontera, A. N. Parmar, F. E. Marshall, C. Lochner, & R. H. D. Corbet, 1998, IAUC 6818.

“XTE J1858+034”, T. Takeshima, R. H. D. Corbet, F. E. Marshall, J. H. Swank, & D. Chakrabarty, 1998, IAUC 6826.

## **Task 5030/96-02-00 – GLAST/GTOTE**

### **Alexander Moiseev:**

#### **GLAST Project:**

- GLAST prototype beam test at SLAC (10/01/97 – 10/30/97). I provided Anti-coincidence detector (ACD) for this prototype.
- Presentation at the GLAST collaboration meeting (GSFC, 2/12/98) with the data analysis of the beam test results along with the Monte Carlo simulations of the ACD.
- Presentation at the GLAST electronic meeting (Stanford, 3/16/98) with the design of the ACD interface and organization of the triggering.
- Preparation of the paper to be submitted to NIM with GLAST prototype beam test results.
- Work on the paper devoted to the capability of GLAST calorimeter to detect gamma ray lines from dark matter particles annihilation.
- Laboratory study of different variants of ACD design for GLAST.
- Designing of ACD for GLAST single tower prototype to be tested at SLAC in fall of 1999 and launched by balloon in 2000.

#### **ACCESS Project:**

- Presentation at the ACCESS meeting with the preliminary Monte Carlo and numerical results on the calorimeter design.

#### **BESS Project:**

- Review of the data analysis done for the 1995 balloon flight with BESS. Contribution to the resulting paper to be submitted to PRL.

#### **Planned activity from 4/1/98 to 9/30/98:**

- Continuation and accomplishment of the laboratory study of different designs for the GLAST ACD;
- detailed consideration of the lab study results along with extensive Monte Carlo simulations with the task to make a decision on the best ACD for GLAST.
- Development of the principal scheme of the GLAST single tower ACD which will be tested in a beam at SLAC in fall of 1999 and will be launched by a balloon in 2000.
- Designing and fabrication pieces of ACD for single tower prototype.
- Monte Carlo simulations for the different variants of the ACCESS calorimeter with the goal to choose the most effective design.

**Task 5030/97-02-00 – ASTRO-E GOF and**

**Task 5030/93-03-00 – ASCA-GOF**

**Ken Ebisawa:**

ASCA GOF, Astro-E GOF

**PROJECT WORK**

- # Answered questions from US ASCA guest observers regarding ASCA data analysis and calibration (mainly through the [ascahelp@olegacy.gsfc.nasa.gov](mailto:ascahelp@olegacy.gsfc.nasa.gov) help desk).
- # Participated in the ASCA AO6 proposal review from October 15 to 17 as a technical reviewer.
- # Participated in the Astro-E Science Working Group Meeting from March 9 to March 13 in Hawaii.
- # Wrote the "Astro-E Project and Data Management Plan", and distributed to Astro-E team members in US and Japan.
- # Participated in the discussion for design of the Astro-E FITS file formats and Astro-E simulator with other US and Japanese Astro-E scientists.

**SCIENTIFIC RESEARCH**

- # The ASCA AO6 proposal entitled "1E1024.0-5732 - X-RAY PULSAR OR A WOLF-RAYET STAR?" was accepted.
- # The two XTE AO3 proposals entitled "HARD X-RAY OUTBURSTS AND SPECTRAL VARIATIONS OF GX339-4" and "SPECTRAL VARIATIONS OF CYG X-1 SLICED WITH HARD-XRAY INTENSITIES" were accepted.
- # Participated in the 191st American Astronomical Society meeting at Washington D.C. from January 6 to 10, and presented a poster paper entitled ASCA Observation of the high mass binary 2S0114+650.
- # Worked with Dr. Asai (ISAS) and others on the paper "ASCA Observations of Super-soft X-ray Source CAL87" (submitted to ApJ Letter).
- # Working on the paper "X-ray Energy Spectra of Super-soft X-ray Sources CAL87 and RXJ0925.7-4758" (to be submitted to ApJ).
- # Submitted to the two AXAF AO1 proposals, ORIGIN OF THE GALACTIC RIDGE X-RAY EMISSION and SPECTROSCOPY OF THE SUPER-SOFT SOURCE CAL87.
- # The paper, "Simultaneous ASCA and RXTE Observations of Cygnus X-1 during its 1996 State Transition", CUI, W., Ebisawa,

K., Dotani, T. and Kubota, A. was published (1998, ApJ Letter 493, L75).

# The paper "Detection of Absorption-Line Features in the X-Ray Spectra of the Galactic Superluminal Source GRO J1655-40", by Ueda, Y., Inoue, H., Tanaka, Y., Ebisawa, K., Nagase, F., Kotani, T., Gehrels, N., was published (1998, ApJ Letter, 492, 782).

#### WORK PLANNED FOR THE NEXT 6 MONTHS

##### PROJECT WORK:

# Update the Astro-E Project Data Management Plan as required.

# Continue discussion of the Astro-E event FITS file format, and fix the preliminary version of the FITS files.

##### SCIENTIFIC RESEARCH:

# Submit the paper "X-ray Energy Spectra of Super-soft X-ray Sources CAL87 and RXJ0925.7-4758".

# Participate in the meeting HIGH ENERGY PROCESSES IN ACCRETING BLACK HOLES: OBSERVATIONAL AND THEORETICAL ADVANCES DUE TO ONGOING SPACE MISSIONS in Sweden from June 30 to July 3, and give an invited talk.

# Invite Ms. Mamiko Nishiuchi (graduate student of Kyoto Univ.) to GSFC and work with the ASCA and XTE simultaneous data of GRO J1744-28.



## **Task 5030/97-03-00 – Detector Technology**

### **John F. Krizmanic:**

#### Summary of Work:

1. Orbiting Wide-angle Light collectors (OWL), Ultra-high Energy Cosmic Ray Experiment: I was part of the local organizing committee for the Workshop for Observing Giant Cosmic Ray Airshowers for  $E > 10^{20}$  eV Particles from Space. I also one of the editors of the workshop proceedings which should be published in June 1998.
2. The Gamma-ray Large Area Space Telescope (GLAST): I have performed an initial derivation of the requirements needed by the calorimeter ASIC electronics.
3. VLSI Electronics Development: I have been developing the resources and methodologies needed to evaluate ASIC electronics developed at GSFC. I have performed a first round of characterization measurements on a GSFC-designed ASIC which is to be integrated to a gas microstrip detector.
4. Isotope Matter Antimatter eXperiment (IMAX): I have begun to incorporate new pattern recognition/event reconstruction algorithms into the analysis software to significantly increase the acceptance of the IMAX instrument at lower rigidities.

#### Future Planned Work:

1. Orbiting Wide-angle Light collectors (OWL), Ultra-high Energy Cosmic Ray Experiment: I will be working this summer with a graduate student from The Johns Hopkins University to develop an OWL airshower, physics generator with the goal of having a fully operational OWL physics simulation by the fall 1998.
2. The Gamma-ray Large Area Space Telescope (GLAST): I will be working with the GFSC-GLAST group to fully characterize the calorimeter readout ASIC and design the next generation prototype.
3. VLSI Electronics Development: I will be developing a generic, computer-based ASIC characterization system. The goal is to have a resource which could fully test and characterize any ASIC developed at GSFC with a minimal amount of customized hardware development for each different ASIC design.
4. Isotope Matter Antimatter eXperiment (IMAX): I plan on having the analysis software update finished and finish the cosmic ray induced atmospheric muon flux measurements.
5. Novel Semiconductor Detector Development: I plan on performing detailed characterization measurements of the silicon

microstrip detector developed at GSFC. The results of these measurements will be used to fully quantify the GSFC fabrication process and identify areas of possible detector performance improvement.

## **Task 5030/97-05-00 – INTEGRAL Software**

**Juan E. Naya:**

My work in this period has been mainly dedicated to two different projects of gamma-ray spectroscopy: the Gamma Ray Imaging Spectrometer (GRIS) and the INTErnational Gamma Ray Laboratory (INTEGRAL). My contribution is described in the following sections.

### **1. GRIS**

#### **1.1 Combined Study of the GRIS/COMPTEL $^{26}\text{Al}$ Galactic Observations**

I have been working on the combination of the GRIS and COMPTEL observations to derive of a new  $^{26}\text{Al}$  map that is more sensitive to the diffuse emission. This work is being done in collaboration with the Max Plank, Munich and I stayed for 3 weeks in Garching to work on this issue. This work has not be concluded but preliminary results show that the approach followed in this study can provide with new and interesting information.

#### **1.2 Analysis of the $^{60}\text{Fe}$ Galactic emission with GRIS**

I've studied the GRIS observations on  $^{60}\text{Fe}$  diffuse gamma-ray line emission from the Galactic center. The results of this study have been recently accepted for publication in the Astrophysical Journal Letters.

### **2. INTEGRAL Spectrometer (SPI)**

#### **2.1 Matrix Response Generation for SPI**

The calculation of the matrix response is a very important issue for the future analysis of the astrophysical data. Since SPI has imaging capabilities, its efficiency in function of the energy and direction has to be known in detail. The characterization of the instrument is not trivial since it can take months and even years of calculation time. I have been developing and testing a new method for the calculation of the SPI response function. With this method the time required for the calculation of the response will be reduced by two orders of magnitude. The realists are very promising and they have been presented in multiple SPI meetings held over the last months.

#### **2.2 Background Studies on SPI**

I have started a collaboration with the Southampton group to do a validation of their calculations on the SPI background. This is being done by comparing the predicted

and the measured background on GRIS. The availability of data in different configurations makes possible to do a detailed study of the background lines resulting from the materials activation. The comparison between the measurements and the predictions will allow us to validate the calculation and to extrapolate the results on the predictions made for SPI.

### 3. Attended Meetings

COMPTEL 26A1 results workshop, Munich December 1-17, 1997

SPI meeting, Munich September 25-26, 1997

SPI meeting, Toulouse January 20-21, 1998

SPI meeting, Rome April 22-24, 1998.

## **Task 5030-98-01-00 – Space Physics**

### **Matthew G. Baring:**

During the last half year, I focused on three projects in topics on high-energy astrophysics. The first of these was the completion of an application of non-linear shock acceleration theory to supernova remnants (SNRs) with Dr. Don Ellison, Dr. Steve Reynolds (North Carolina State), and Dr. Isabelle Grenier (CEN-Saclay, Paris). These are thought to be good candidates for the unidentified sources observed by EGRET above 100 MeV. We have strong indications that SNR shock environments, which accelerate the particles responsible for gamma-ray emission, may not permit emission at TeV energies; such emission is not associated with the EGRET sources, as is confirmed by upper limits determined by the Whipple Observatory. We have developed a model of gamma-ray emission in SNRs including pion particle physics of proton-proton collisions and electromagnetic processes such as bremsstrahlung and inverse Compton scattering. These are computed in conjunction with output from the Monte Carlo simulation to predict gamma-ray fluxes in SNRs. We find that we conform with the Whipple upper limits and produce low electron/proton ratios in the accelerated populations. These cause an enhancement of gamma-ray emission relative to X-ray radiation in remnants, and we provide the first coherent means of determining such abundance ratios. Our results have been presented in a paper submitted to the *Astrophysical Journal*, and we are awaiting the referee's report.

In addition, Dr. Ellison, Dr. Frank Jones (GSFC) and myself have applied the non-linear shock acceleration model to the problem of ion acceleration at the quasi-perpendicular solar wind termination shock. We focused specifically on the issue of pick-up ion injection, which can dramatically alter the efficiency of acceleration at the termination shock due to the superthermal speeds possessed by the pick ion population. We found that only modest levels of scattering are necessary to match the predicted levels of proton, helium and carbon ions in the outer heliosphere, and that the presence of pick-up ions in the solar wind dismisses any purported need for pre-acceleration of ions in order to meet the observational flux constraints. Our results were submitted in a paper to the *Astrophysical Journal*, and following a favorable report from the referee, we are in the process of putting the final touches to the paper before acceptance for publication.

Finally, together with Dr. Alice Harding (GSFC), I have been focusing on an offshoot of our recent work on photon splitting in pulsars. We have demonstrated that splitting can suppress pair creation in pulsars with high magnetic fields, and thereby hypothesize the existence of a high field "death-line" for radio pulsars. We have determined the position of this line in the conventional pulsar P-Pdot diagram, using detailed computations of photon propagation and attenuation in general-relativistic

neutron star magnetospheres, and find that our predicted position provides an upper boundary that is comfortably proximate to the observed radio pulsar population. This work has become very topical given the recent reports of several so-called anomalous X-ray pulsars with no radio counterparts. Our results provide a simple and natural explanation for this population, whose long periods and large  $\dot{P}$  imply enormous magnetic fields, of the order of 1000 TeraGauss or so. We are currently preparing a paper on this subject for submission to the Astrophysical Journal, and will present our results at the Elba Workshop on Pulsars and Supernova Remnants next month.

REPORT DOCUMENTATION PAGE			Form Approved OMB No. 0704-0188	
<small>Public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302, and to the Office of Management and Budget, Paperwork Reduction Project (0704-0188), Washington, DC 20503.</small>				
1. AGENCY USE ONLY (Leave blank)		2. REPORT DATE 5/31/98		3. REPORT TYPE AND DATES COVERED Contract Technical 10/1/97 - 3/31/98
4. TITLE AND SUBTITLE High Energy Astrophysics Research and Programmatic Support			5. FUNDING NUMBERS NAS5-32490	
6. AUTHOR(S) Angelini, L., et al,				
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) Universities Space Research Association (USRA) 10227 Wincopin Circle, Suite 212 Columbia, Maryland 21044			8. PERFORMING ORGANIZATION REPORT NUMBER 11	
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES) NASA/Goddard Space Flight Center Greenbelt, Maryland 20771			10. SPONSORING/MONITORING AGENCY REPORT NUMBER	
11. SUPPLEMENTARY NOTES *Staff members prepare individual reports on their activities. Authors are listed in the table of contents.				
12a. DISTRIBUTION/AVAILABILITY STATEMENT Unclassified-unlimited			12b. DISTRIBUTION CODE	
13. ABSTRACT (Maximum 200 words)  This report reviews activities performed by members of the USRA contract team during the six months of the reporting period and projected activities during the coming six months. Activities take place at the Goddard Space Flight Center, within the Laboratory for High Energy Astrophysics. Developments concern instrumentation, observation, data analysis, and theoretical work in Astrophysics. Missions supported include: Advanced Satellite for Cosmology and Astrophysics (ASCA), X-ray Timing Experiment (XTE), X-ray Spectrometer (XRS), Astro-E, High Energy Astrophysics Science Archive Research Center (HEASARC), and others.				
14. SUBJECT TERMS Astrophysics; research; observations; data analysis; archive; guest investigator; gamma-ray; x-ray			15. NUMBER OF PAGES 60	
			16. PRICE CODE N/A	
17. SECURITY CLASSIFICATION OF REPORT unclassified	18. SECURITY CLASSIFICATION OF THIS PAGE unclassified	19. SECURITY CLASSIFICATION OF ABSTRACT unclassified	20. LIMITATION OF ABSTRACT	

## GENERAL INSTRUCTIONS FOR COMPLETING SF 298

The Report Documentation Page (RDP) is used in announcing and cataloging reports. It is important that this information be consistent with the rest of the report, particularly the cover and title page. Instructions for filling in each block of the form follow. It is important to *stay within the lines* to meet *optical scanning requirements*.

### Block 1. Agency Use Only (Leave blank).

**Block 2. Report Date.** Full publication date including day, month, and year, if available (e.g. 1 Jan 88). Must cite at least the year.

**Block 3. Type of Report and Dates Covered.** State whether report is interim, final, etc. If applicable, enter inclusive report dates (e.g. 10 Jun 87 - 30 Jun 88).

**Block 4. Title and Subtitle.** A title is taken from the part of the report that provides the most meaningful and complete information. When a report is prepared in more than one volume, repeat the primary title, add volume number, and include subtitle for the specific volume. On classified documents enter the title classification in parentheses.

**Block 5. Funding Numbers.** To include contract and grant numbers; may include program element number(s), project number(s), task number(s), and work unit number(s). Use the following labels:

C - Contract	PR - Project
G - Grant	TA - Task
PE - Program Element	WU - Work Unit Accession No.

**Block 6. Author(s).** Name(s) of person(s) responsible for writing the report, performing the research, or credited with the content of the report. If editor or compiler, this should follow the name(s).

**Block 7. Performing Organization Name(s) and Address(es).** Self-explanatory.

**Block 8. Performing Organization Report Number.** Enter the unique alphanumeric report number(s) assigned by the organization performing the report.

**Block 9. Sponsoring/Monitoring Agency Name(s) and Address(es).** Self-explanatory.

**Block 10. Sponsoring/Monitoring Agency Report Number.** (If known)

**Block 11. Supplementary Notes.** Enter information not included elsewhere such as: Prepared in cooperation with...; Trans. of...; To be published in.... When a report is revised, include a statement whether the new report supersedes or supplements the older report.

**Block 12a. Distribution/Availability Statement.** Denotes public availability or limitations. Cite any availability to the public. Enter additional limitations or special markings in all capitals (e.g. NOFORN, REL, ITAR).

DOD - See DoDD 5230.24, "Distribution Statements on Technical Documents."

DOE - See authorities.

NASA - See Handbook NHB 2200.2.

NTIS - Leave blank.

### Block 12b. Distribution Code.

DOD - Leave blank.

DOE - Enter DOE distribution categories from the Standard Distribution for Unclassified Scientific and Technical Reports.

NASA - Leave blank.

NTIS - Leave blank.

**Block 13. Abstract.** Include a brief (Maximum 200 words) factual summary of the most significant information contained in the report.

**Block 14. Subject Terms.** Keywords or phrases identifying major subjects in the report.

**Block 15. Number of Pages.** Enter the total number of pages.

**Block 16. Price Code.** Enter appropriate price code (NTIS only).

**Blocks 17. - 19. Security Classifications.** Self-explanatory. Enter U.S. Security Classification in accordance with U.S. Security Regulations (i.e., UNCLASSIFIED). If form contains classified information, stamp classification on the top and bottom of the page.

**Block 20. Limitation of Abstract.** This block must be completed to assign a limitation to the abstract. Enter either UL (unlimited) or SAR (same as report). An entry in this block is necessary if the abstract is to be limited. If blank, the abstract is assumed to be unlimited.